JANUARY 1977 $1.50 in NORTH AMERICA

BYTE

the small systems journal



VOLUME 2, Number 1



SWTPC 6800

★ **COMPLETE WITH 2K OF MEMORY**
★ **SERIAL INTERFACE**
★ **STANDARD ROM MONITOR (Motorola MC 6830L7)**
★ **4K AND 8K BASIC AVAILABLE**

Always the best value in hardware and now an outstanding selection of software too. What more could you want in a computer system? For less than four hundred dollars you get everything you need—ready to connect to a terminal and go to work. No surprises, no funny business, just good reliable hardware in a very practical system that may be expanded to meet almost any later need.

Memory and interfaces are not extra cost items in our system. A standard Motorola MIKBUG® ROM monitor makes the system completely compatible with Motorola software and eliminates any need for console switches and light. Data may be entered from the terminal in convenient hexadecimal form. The power supply is adequate to operate a fully expanded system with up to 24K of memory and up to eight (8) interfaces—simultaneously.

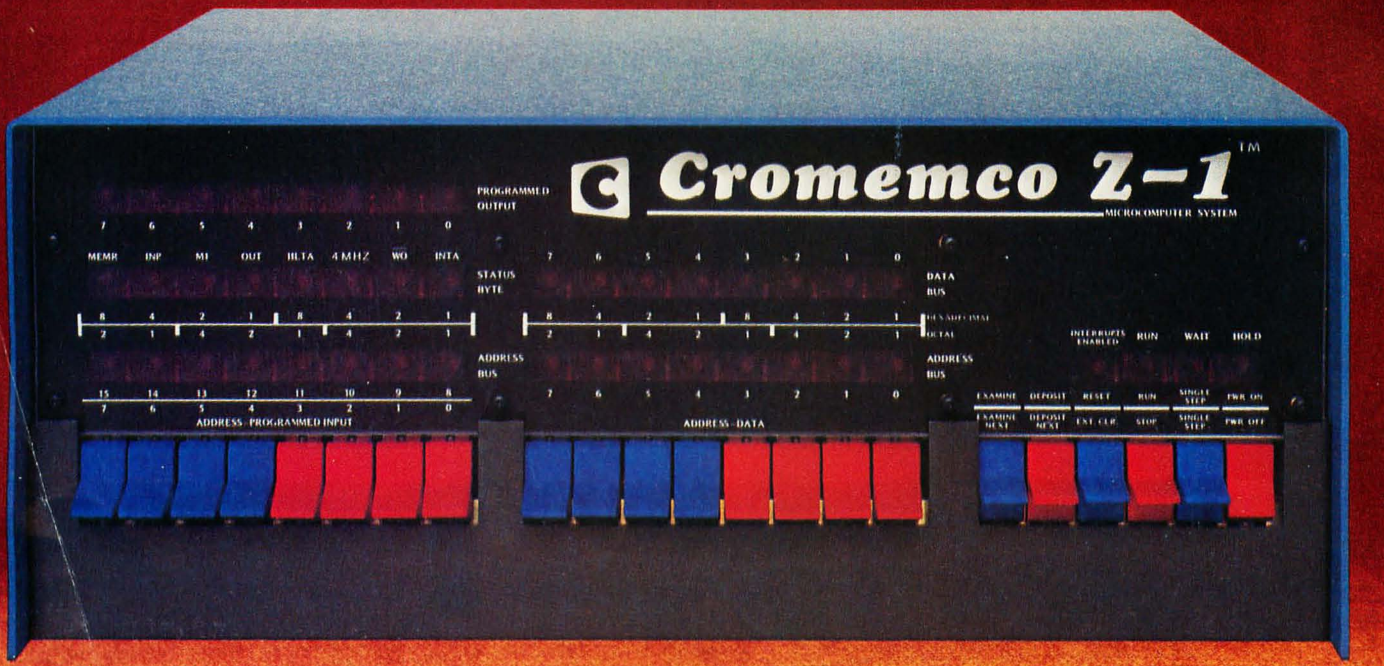
See the 6800 and our peripheral equipment at your nearest dealer, or write for a complete description.

MP-68 COMPUTER KIT—with serial interface, 2K of memory and ROM monitor **$395.00 ppd**

® Motorola

master charge · Your BankAmericard welcome here

Southwest Technical Products Corporation, 219 W. Rhapsody, San Antonio, Texas 78216



This is the industry's most powerful microcomputer

(it's also a powerful Z-80 μP development system)

Uses high-speed Z-80 μP

You see here a major new development in microcomputers: the Cromemco Z-1.

It is the fastest and most powerful microcomputer available.

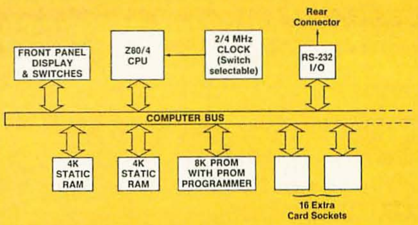
It gets its speed and power from a selected version of the new Z-80 microprocessor that can operate at a 4 MHz clock rate. (The Z-1 also lets you switch to 2 MHz to be compatible with older systems.)

μP development system

In addition to being a powerful microcomputer the Z-1 is a major **μP development system.** It will give you a big head start in developing **your circuits** around the Z-80 μP. All you need do is plug your breadboards into the Z-1's 16 or more extra sockets. You're right into the computer bus.

Broad "S-100" support

What's more, the Z-1 offers you all kinds of peripherals and software. It uses the standard "S-100"



bus supported by over a dozen manufacturers. And all Cromemco peripherals (PROM memory and programmer, RAM memory, analog I/O, color TV interface, etc.) just plug into the Z-1's extra sockets.

Cromemco also provides complete software support: a monitor, assembler, BASIC interpreter and more to come soon.

Another thing: you can bet the Z-1 won't be obsoleted. Future CPU cards can plug in for the present CPU card.

Not a kit

The Z-1 comes completely assembled and tested. It's a quality, commercial-grade microcomputer. It is not available as a kit. Just plug it into the 110-volt line and you're ready to go.

The Z-1's ready, too. It's being shipped. And for all you get, the low $2495 price is a pleasant surprise. It's especially pleasant when you compare it with the price of any **complete, assembled** microcomputer with all the Z-1's features.

Call now and get our brochure on this new system which is so important in working with the Z-80.

Z-1 components

- Z-80/4 CPU
- 8K static RAM
- Capacity for 8K PROM
- PROM programmer
- Resident monitor in PROM
- RS-232 I/O
- Full 22-slot motherboard and connectors
- Fan installed
- Not a kit; completely assembled

Cromemco
Specialists in computers and peripherals
2432 CHARLESTON RD., MOUNTAIN VIEW, CA 94043 • (415) 964-7400

In This BYTE

Terry Dollhoff provides readers with some food for thought on hashing techniques. Turn to **Making Hash With Tables** to find out what it means to hash data as a method of improving table access time. The straightforward way of seeking data in a table (searching each element in turn) is far from the most time efficient, as you'll discover by considering Terry's arguments.

For an output only interface, you don't necessarily have to use a UART to drive a Teletype printer. Gregory C Jewell shows **How to Drive a Teletype Without a UART** using five standard TTL integrated circuits.

How do you drive a tape recorder's head directly, and read data directly? If you read David M Allen's article in this issue, you'll find out that **Saturation Recording's Not All That Hard** after all. David shows a simple tape driver circuit, input signal processor and the design of software for direct digital recording with audio tape heads on cassette recorders.

Watts Inside a Power Supply? Find out by reading Gary Liming's account of power supply basics. You'll find that there are indeed watts lost inside a power supply, the reason these items invariably come with some form of heat sink. After reading Gary's article you'll have some good background information in your memory banks for evaluating the various power supply schemes which are used in practice, and why such schemes are used.

Altair BASIC (in whatever form you have it) is an excellent aid to the utilization of an 8800 system. However, there is that residual problem of putting in a 20 byte bootstrap program every time you turn power on. In this issue, a short article by Jim Kreitner shows you how to **Pick Up BASIC by PROM Bootstraps.**

Who knows what the bears and bulls will be doing next in the stock market? Play **Black Friday,** a BASIC game by Bob Baker, and you'll get a heuristic feel for what happens through the powerful tool of simulation. Will X-Pando do better than Slippery Oil after a simulated year of trading? Play the game and find out.

Newcomers may wonder what is meant by the term "direct access storage device." This is the most useful form of mass storage, a form which is the dream and goal of every small system hacker who has passed the beginning stages of programming applications of his or her computer. To help define the terminology for the novice, reader Curt Hill has provided an elementary article on the types and uses of direct access storage.

The SYS 8 monitor as it is supplied by IMSAI and Processor Technology is a self-contained operating system for 8080 based microprocessors which comes equipped with its own set of executive commands. These commands are used for calling programs that are resident in the system. Wouldn't it be great if programs that are not part of the monitor could be part of the executive command table? This was the conclusion of Willard I Nico. He decided to have easy availability of his most used programs by adding them to the executive command table. He describes how you too can easily accomplish this in his article **SYS 8 1/2 – Your Own Executive Commands.**

Representations of two dimensional game boards as the bits of various bytes in your computer's memory can often be chosen to help facilitate evaluation and strategy computations. In **Computer Models For Board Games,** Russell R Yost Jr presents some basic background information on the problem and suggestions for representations useful in the games of TACTIX and HEXPAWN.

For use when testing out your hardware, the idea of **The Built-In Logic Tester** can prove quite useful. K W Christner discusses the concept in a short article on his version of a logic probe.

Riddle of the Month: What is not like an elephant with a suntan?

An EROM which forgets its memory pattern due to exposure to ultraviolet light.

Build the **"Coffee Can Special" EROM Eraser** described by Lawrence Burbey in order to convert white elephant EROMs into blanks ready for reprogramming.

Video interfaces often produce an EIA composite video signal as the principal output. What do you do when you have a commercial digital monitor with separate sync inputs of the type used in display terminals? Why, that's when you follow David Rosen's lead and **Separate Your Sync** by tapping the interface at a nonstandard point.

June BYTE had an article on ELM, an Eloquent Little Monitor. In this issue, author G H Gable describes a method of **Using Interrupts to Speed Up an ELM.** The use of interrupts and a tape drive with a direct memory access interface make a valuable extension of the basic monitor concept.

In June and July a survey was conducted of computer hobbyist clubs in the US and Canada. The questionnaire covered such areas as number of members per club, types of computers owned, applications for the computers and the members' backgrounds. In his article, **A Computer Hobbyist Club Survey,** David Caulkins releases the results of the survey and explains some of the conclusions that he has reached as a result of the survey.

Introducing Sol Systems

A complete computer/terminal concept with all the standard features, software and peripheral gear you want in your personal computer.



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In the Queue

Foreground

Background

Nucleus

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Editorial

The Appliance Computer, Circa 1977

by Carl Helmers

With the beginning of the new year, it's time to return to the theme of the "ideal" personal computing system, the ne plus ultra in terms of design finesse, convenience and low price. In short, a quality packaged product ready to be programmed by the user . . . the same concept found in the programmable calculator, but applied to the general purpose computer system instead. This product is on the way. My "authoritative" pronouncement on the future of the field during 1977 is that 1977 is to be the year of the "Appliance Computer." Now that I've made my pronouncement, you ask in reply "now how can Helmers make a crazy statement like that?" The rest of this month's commentary concerns the reasons for this summary of the coming year, a view from the root node of an information tree.

Quite simply, the "appliance computer" is the concept of a true finished product desk top general purpose computer which can be purchased at your local dealer, a complete package of hardware with supporting systems software at a reasonable price. It is the software experimenter's dream machine, a computer where the only concerns are the generation of programs and the hardware is just assumed to exist and work properly. It is the starting point of applications and systems programming experimentation. The appliance computer is the personal computing system which does not require that its owner own an oscilloscope, a complete electronics laboratory, or have experience in the repair and tuning of hardware.

The systems hackers and hardware hackers will of course complain about the very concept of the appliance computer, which is fine. "You're too constrained by someone else's choice of compatible options." "You're limited by a particular style of engineering." "In my perfect system, I'd do this instead." "I wouldn't be caught dead with such a kluge in *my* system." There is no doubt that there is a lot of pleasure to be gained from the ego involvement of hardware creation and system design. The appliance computer hardly eliminates that pleasure — for those who are sophisticated and knowledgeable enough to enjoy it. They simply avoid buying appliances.

But consider the appliance computer in analogy to the musical instrument. Most of us musicians (amateur like myself, or professional) get our jollies out of playing the instrument, not out of building it. Sure, I do some weird things like designing an attachment to my baby grand player piano so that my computer programs can play it too; but I do so to enhance my ability to play music, and then I do a custom design only because there are no commercial products. I am primarily a user of the piano, not the builder or designer of the piano system. The builder of the piano, some craftsman at Steinway circa 1910, simply put together a very specific and well designed set of hardware which I program with my own software creations, via my finger tips (and later via rolls or solenoid valves in the pneumatics).

So why is it appropriate that 1977 be termed the year of the appliance computer? I have inputs from numerous sources to tell me that the personal computing products are shaking down into finished systems. For example, just take a look at the class and quality of the new Digital Group cases — they're the kind of finished product professionalism one would expect on a computer table in the livingroom of a home. Now, if only Robert Suding's brainchild were completely assembled and tested at the same price. As another example, take a look at the level of case design sophistication and engineering quality represented by the new Processor Technology SOL systems. Again, it's still a kit, but it augurs well for the coming year. Take a look as well at the STM BABY computer. Here is a finished product, not a kit, which is initially a bit more limited in scope as a general purpose system than some of the other products, but which before the year is out will have a complete set of options including mass storage and a high level language. Then there is Steven Jobs' and Steve Wozniac's Apple Computer, presently only available in single board form without case, but soon to become a finished product item at dealers coast to coast, with a case as previewed at Atlantic City last September. There are others as well, firms which have yet to advertise but which have exciting products we may see at dealers in the near future. These include the Gremlin

Continued on page 14

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal systems, or who have knowledge which will prove useful to our readers. Manuscripts should have double spaced typewritten texts with wide margins. Numbering sequences should be maintained separately for figures, tables, photos and listings. Figures and tables should be provided on separate sheets of paper. Photos of technical subjects should be taken with uniform lighting, sharp focus and should be supplied in the form of clear glossy black and white or color prints (if you do not have access to quality photography, items to be photographed can be shipped to us in many cases). Computer listings should be supplied using the darkest ribbons possible on new (not recycled) blank white computer forms or bond paper. Where possible, we would like authors to supply a short statement about their background and experience.

Articles which are accepted are typically acknowledged with a binder check 4 to 8 weeks after receipt. Honorariums for articles are based upon the technical quality and suitability for BYTE's readership and are typically $25 to $50 per typeset magazine page. We recommend that authors record their name and address information redundantly on materials submitted, and that a return envelope with postage be supplied in the event the article is not accepted.■

Sol Systems put it all together. One source for hardware and software. One source for engineered compatibility of computer and peripherals. That's the Sol plan.

Though the microprocessor made the powerful small computer possible, a lot of folks found out early efforts in the marketplace were selling the sizzle a lot more than the steak. After an initial investment of several hundred dollars, you ended up with some nice parts, but no memory of any kind, no I/O devices or interfaces, no display, printout or software.

The Sol plan ends all that. Processor Technology takes the position that it's far better to be right than first. So let's get down to the Sol no tricks plan.

For $995 in kit form, the first complete small computer

Standard is a basic word at Processor Technology. The Sol-20 has more standard features than any other small computer we know of. Here's what you get.

8080 microprocessor* 1024 character video display circuitry* 1024 words of static low-power RAM* 1024 words of preprogrammed PROM* a custom, almost sensual 85-key solid-state keyboard* audio cassette interface capable of controlling two recorders at 1200 baud* both parallel and serial standardized interface connectors* a complete power supply* a beautiful case with solid walnut sides* software which includes a preprogrammed Prom personality module and a cassette with Basic-5 language plus two sophisticated computer video games* the ability to work with all S-100 bus (Altair 8800/IMSAI/PTC) products.

There are no surprises. Everything you need to make it work is here. In kit form, nominal assembly time from our fully documented instructions is four to seven evenings.

Or start with the Sol-PC for just $475

You can begin your Sol system with the all on one board Sol-PC kit. It has all the memory and interface electronics including video display, keyboard interface, audio cassette interface, all necessary software and the ability to accept the full Processor Technology line of memory and interface modules. Use the Sol-PC as the basis of a microcomputer, low cost CRT terminal or editing terminal

And these specs are standard

Display: 16 lines of 64 characters per line.
Character set: 96 printable ASCII upper and lower case characters plus 32 selectable control characters.
Display position: Continuously adjustable horizontally and vertically.
Cursor: Selectable blinking. Solid video inversion. Programmable positioning standard.
Serial interface: RS-232 and 20-mA current loop, 75 to 9600 baud, asynchronous.
Parallel interface: Eight data bits for input and output; output bus is tristate for bidirectional interfaces; levels are standard TTL.
Keyboard interface: Seven-level ASCII encoded, TTL levels.
Microprocessor: 8080, 8080A, or 9080A.
On-card memory: 1024 bytes PROM (expandable to 2048 bytes), 2048 bytes RAM.
External Memory: Expandable to 65,536 bytes total ROM, PROM, and RAM.
Video signal output: 1.0 to 2.5 volts peak-to-peak. Nominal bandwidth is 7 MHz.
Power required (±5%): +5 volts at 2.5 amperes, +12 volts at 150 mA, and −12 volts at 200 mA.

The Sol plan, completely expandable.

By filling the basic main frame with tailor made Processor Technology plug-in PC boards, you can really expand the computing power and flexibility of your Sol-20 Personal Computer.

New items are being announced frequently, but right now, here are some of the

things you can add to your Sol-20. The ALS-8 Firmware module is an assembly language operating system to give you the power to develop and run programs. Use it to quickly write, edit, assemble, de-bug and run your own programs. Some say it's the most useful software development on the market today, but modesty prohibits.

And when it comes to add-on memory boards, you've come to the right place. We've probably got more than anyone else. Choose from 2K ROM or 4, 8 or 16K RAM (read all about the 16KRA board on the last page of this ad). The PT 2KRO will accept up to eight 1702A or 5203Q erasable, reprogrammable memories (EPROM's) with the ability to store in a non-volatile fashion up to 2048 eight-bit words.

Our read/write memories are the industry standards for high reliability. We know, because we have literally scores of customer letters saying "Your memory modules work and keep on working."

To help you solve additional interfacing problems, add the 3P+S I/O module. Here's a board with two 8-bit parallel I/O ports with full handshaking logic and a serial data rate that can be set anywhere between 35 and 9600 baud. Set up control conditions for both parallel and serial ports. Data and error flags can be polled.

A full line of Sol-20 tailored peripherals

No computer can do the full job without the right set of peripheral gear. PT has sought out the best manufacturers of peripheral equipment and worked with them to give you a choice of quality so you can get the most out of your Sol-20. Choose from line and serial printers, perforated tape readers and punches, floppy disk memories, black and white or color graphics displays, A/D, D/A converters and more.

Software, the Computer Power Essential

A big part of making the first complete small computer is providing you with a wide range of easy to use, easy to obtain, low cost software. For the Sol-20, we've developed a whole group of offerings. And more are on their way.

TREK 80

Based on the NBC television series STARTREK, this 8K assembly language program uses the VDM graphics capability for real time war with the Klingons. No holds barred, they're out to get you from each of the 100 quadrants. TREK 80 resides and runs in 8K of memory and requires the PTC Sol or VDM-1.

New PT 8K Basic

Processor Technology has the fast new BASIC you've needed for so long. Using our superior BCD math, the speed of the new language is double that of our own fast BASIC-5. To multiple program capability, we've added strings, multidimensional arrays and multi-line, multi-variable, user functions. This is the BASIC for full capability systems. Look at the BUSINESS ANALYSIS program example in the manual to find out how PT 8K BASIC gives you more while using less memory for the working program.

Five reasons why it's so good

1. Strings are not limited to a length of 256 characters and can extend to the bounds of memory.
2. Renumbering of lines with full gosub, etc. updating. Also EXAM and FILL allow for direct memory operations while IN and OUT provide direct I/O capability.
3. Every statement is fully implemented. RESTORE, for instance, restores the data pointer as usual. BUT, with PT 8K BASIC, RESTORE 100 will set the pointer to the data located at line 100.
4. Fully implemented string and math functions include all of the standards — VAL, STR, ASC.... EXP and LOGI and LOG. Also, the more advanced statements such as ON-GOTO and IF THEN ELSE along with a loop EXIT are provided.
5. PT 8K BASIC has a 'perfect' implementation of PRINT USING which saves program memory space while still providing more capability than the usual PRINT USING.

The new PT 8K BASIC is similar to the version we're developing for ROM. You use it here before buying the more expensive ROM.

You'll find your PT 8K BASIC also includes both a built-in VDM driver and special editor. The cassette version also includes named program SAVE and LOAD for the CUTS Cassette interface or Sol.

New 8080 FOCAL™ DEC

8080 FOCAL has been updated to include operator precedence and all other standard FOCAL conventions. It also has a driver for VDM-1 display and PT Cassette program SAVE and LOAD This version is available only on CUTS Cassette and resides in 8K of memory.

GAMEPAC 1 to entertain family and friends

Show off your VDM-1 and computer with this lineup of video games. Each is included on the cassette or paper tape.

TARGET keeps track of your hits and misses while you blast away at the moving target. You and your family can get together for whole evenings at a time with this one.

ZING. Learn hexidecimal arithmetic fast with this VDM game as two players keep the five balls in the air. If both of you get too good . . . ZING, of course, will make it harder.

LIFE. The Sol or VDM makes a good display for the game of life and this version allows two modes of operation. The universe can be flat or wrapped around on itself. The real meaning of life we'll leave to you but it's fun to watch.

PATTERN. We haven't figured this one out ourselves but it's sure nice to have your computer doing it. You choose the geometric design and how rapidly it changes.

Sol Systems Price List

(prices are net, effective Dec. 1, 1976)

SOFTWARE ITEM with manual	Source	CUTS cassette	Paper tape
BASIC 5 software #2	yes	**	$19.50
8K BASIC	no	$29.00	$37.00
New 8080 Focal	no	$14.50	N/A
TREK 80 video game	no	$ 9.50	$14.50
GAMEPAC 1 video games	no	$ 9.50	$14.50
MATHPACK video calculator	yes	$14.50	$19.50
ASSEMBLER software #1	yes	$14.50	$19.50
ALS 8	no	$35.00	$45.00

**CUTS cassette of BASIC 5 is included FREE with all orders for Sol units or CUTS cassette interfaces. Additional cassettes available for $14.50.

Sol system owners be sure to note Sol system on your order. These special versions use less code and provide easier loading along with more convenient operation. SOLOS, SOLED and CONSOL all have provision for the special versions.

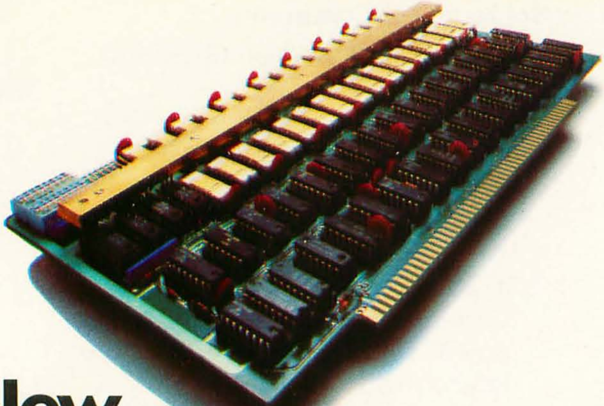
All Processor Technology software is distributed on an individual sale basis for personal use. No license to copy, duplicate or sell is granted with this sale. Each software package has been copyrighted by Processor Technology and all rights therein are reserved.

Sol Terminal Computers	Kit Price
SOL-PC SINGLE BOARD TERMINAL COMPUTER™	$475.*
SOL-10 TERMINAL COMPUTER™ Sol-PC with case, power supply and 70 key solid state keyboard.	$795.*
SOL-20 TERMINAL COMPUTER™ all features of Sol-10 with larger power supply, 85 key solid state keyboard, fan, and five slot expansion backplane.	$995.*

*Sol prices include CONSOL Personality Module. If SOLED Intelligent Editing Terminal Module or SOLOS Standalone Operating System Module is desired instead, add $100. If ordered separately, personality modules are $150 each.

Memory Modules	Kit	Asmbld.
ALS-8 PROM Resident Assembly Language Operating System	—	$425
SIM-1 Interpretive Simulator add-on option for ALS-8	—	$ 95
TXT-2 Text Editing add-on option for ALS-8	—	$ 95
2KRO Erasable PROM module	$ 65	$ 89
4KRA 4096-word Low Power Static RAM	$159	$195
8KRA 8192-word Low Power Static RAM	$295	$375
16KRA 16384-word Dynamic RAM	—	$529
Interface modules		
3P+S Parallel, Serial I/O module	$149	$199
CUTS Computer Users Tape System cassette interface	$ 87	$119
VDM-1 Video Display Module	$199	$295
Mass Storage Systems		
Helios II Disk System™ includes dual PerSci 270 floppy disk drive, cabinet, fan, S-100 bus compatible controller, power supply, system diskette with complete PTDOS software	$1895	$2295
Misc.		
EXB Extender Board	$ 35	$ 45
WWB Wire Wrap Board	$ 40	—

Prices, specifications and delivery subject to change without notice. Please allow up to two weeks for clearance of personal checks. Mastercharge accepted. All orders amounting to less than $30 must include $3 for handling.



New 16K RAM, fully assembled, $529

More bits per buck than ever before on a fully burned in and tested board unconditionally guaranteed for one year.

Processor Technology made the first 4K static RAM modules for the home computer market. Now in a price performance breakthrough we offer you a 16,384 byte dynamic memory module assembled, tested and burned in. Not a kit — and at $529 who'd want to build it from scratch?

Processor Technology gives you the features to make 4K dynamic RAMS work for you.

- Invisible refresh, no waiting while CPU is running.
- High speed 400 nsec access time worst case Z-80 and 8080 compatible.
- Versatile addressing, each 4096 byte segment is individually addressed to any of the sixteen available 4K segments.
- Low power — typically 5 watts when running — the same as most 4K memory modules.
- BATTERY BACKUP capability built-in for standby operation.
- IMPORTANT NOTICE — No 16K memory module available is fully, truly static. 4200/4402 type "static" RAM's have high level, high current clocks with high transient power levels. Any RAM with 12 volt 30 mA clock pulses should not be called "STATIC" just because each memory cell is a flip-flop.

Specifications

Access Time	400 nsec max
Cycle Time	500 nsec max
Rams Used	Intel 2104 or Mostek 4096 types
Capacity	16384 8-bit bytes
Memory Protect	standard on card
Addressing	each 4096 byte page addressable
Operating Power	+7.5 to 10 VDC at 0.4 A typical +15 to +18 V at 100 mA typical −15 to −18 VDC at 20 mA max

See your nearest dealer listed below or contact us directly. Address Processor Technology, 6200 Hollis Street, Emeryville CA 94608, Phone 415/652-8080.

Processor Technology Dealers

CALIFORNIA

The Byte Shop
1514 University Ave.
Berkeley CA 94703

The Byte Shop
2559 South Bascom Ave.
Campbell CA 95008

The Computer Mart
624 West Katella #10
Orange CA 92667

The Byte Shop
2227 El Camino Real
Palo Alto CA 94306

The Computer Center
8205 Ronson Road
San Diego CA 92111

The Computer Store
of San Francisco
1093 Mission Street
San Francisco CA 94103

The Byte Shop
509 Francisco Blvd.
San Rafael CA 94901

The Byte Shop
3400 El Camino Real
Santa Clara CA 95051

The Byte Shop
2989 North Main St.
Walnut Creek CA 94596

FLORIDA

Microcomputer
Systems Inc.
144 So. Dale Mabry Hy.
Tampa FL 33609

GEORGIA

Atlanta Computer Mart
5091-B Buford Hwy.
Atlanta GA 30340

ILLINOIS

The Numbers Racket
518 East Green Street
Champaign IL 61820

itty bitty
machine co., inc.
1316 Chicago Ave.
Evanston IL 60201

The Chicago
Computer Store
517 Talcott Road
Park Ridge IL 60068

INDIANA

The Data Domain
111 South College Ave.
Bloomington IN 47401

MICHIGAN

The Computer Store
of Ann Arbor
310 East Washington
Ann Arbor MI 48104

NEW JERSEY

The Computer Mart
of New Jersey
151 Kline Boulevard
Colonia NJ 07067

Hoboken Computer Works
56 Second Street
Hoboken NJ 07030

NEW YORK

Audio Design Electronics
487 Broadway, Ste. 512
New York NY 10013

The Computer Corner
200 Hamilton Ave.
White Plains NY 10601

The Computer Mart
of Long Island
2072 Front Street
East Meadow, L.I. NY 11554

The Computer Mart
of New York
314 Fifth Ave.
New York NY 10001

Synchro Sound Enterprises
193-25 Jamaica Ave.
Hollis NY 11423

OREGON

The Real Oregon
Computer Co.
205 West 10th Ave
Eugene OR 97401

RHODE ISLAND

Computer Power, Inc.
M24 Airport Mall
1800 Post Road
Warwick RI 02886

TEXAS

The Micro Store
634 South Central
Expressway
Richardson TX 75080

WASHINGTON

The Retail Computer Store
410 N.E. 72nd
Seattle WA 98115

WISCONSIN

The Milwaukee Computer Store
6919 W. North Ave.
Milwaukee WI 53213

CANADA

The Computer Place
186 Queen St. West
Toronto, Ontario M5V 1Z1

Trintronics
160 Elgin St.
Ottawa, Ontario

Processor Technology Corporation

About the Cover . . .

January is the look to the future month. For this month's cover, Robert Tinney hit upon the idea of emphasizing the use of the computer to solve problems and improve the way things are done in a fantasy on a crystal ball theme. Against a drab world picture in browns and yellows, we see the brilliant color of the future in the picture on the terminal. It is also fitting that in this January BYTE, two years after the original Altair publicity in *Popular Electronics*, that it is a MITS Altair that Robert found when he visited Willard Nico and Don Nash to get images to model in his painting.

Update on Machine Readable Printed Programs . . .

In last month's BYTE, we ran a test of the bar code strings needed to make a machine readable printed program. The purpose of the test was to see what would happen when the information was passed through a printing press. An old engineering rule of thumb is that if there is a simple test to be made, try it; this is what we did. Of the five test samples, visual inspection indicates that the low density versions would pass with flying colors. Of the three high density samples, (a), (b) and (d) in figure 4 on page 17, (b) and (d) are totally unacceptable due to the bleeding between the lines near the top of the samples.

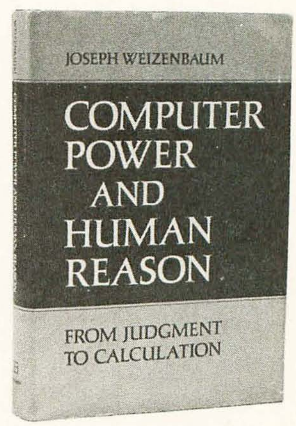
Visual inspection of the high density single width version at (a) shows considerable variation in line and space width as printed, but no complete closure of spaces. Thus the (a) density with a spacing of 8 frames per inch horizontally on the page is a marginal density.

Next month, watch for still another test.■

Book Reviews

Computer Power and Human Reason: from Judgment to Calculation *by Joseph Weizenbaum, W H Freeman and Co, San Francisco, 1976, 300 pp, $9.95.*

I should probably begin by identifying myself as an outsider to the world of "pure" thought and computers. I am among those firmly entrenched in the humanistic tradition. My prejudices run toward poetry rather than programs, and emotion rather than algorithms. Mathematics to me is a mysterious foreign language. When faced with a problem involving more than a few simple operations, my eyes glaze, my palms grow clammy. I am overcome with what by now has become a well-ingrained, almost primordial fear. I give up without a struggle. When Carl Helmers handed me a copy of a book which seemed to focus primarily on computers, my heart and mind rebelled only to become fascinated within a few pages. This book is as much about life as it is about computers.



Computer Power and Human Reason is an exciting, challenging book written by one who must be considered an extraordinary man, Joseph Weizenbaum. He is an MIT professor in the field of computer science. Several years ago he invented a language analysis program called ELIZA which programs a computer to respond like a Rogerian psychotherapist, a program which must have demanded a great deal of sophisticated thought in the use of language and computers. The book is partly a reaction to the history of the program, ELIZA. Here's how a typical ELIZA sequence looked:

I AM SORRY TO HEAR YOU ARE DEPRESSED

It's true. I am unhappy.

DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY

I need some help, that much seems certain.

WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP

Perhaps I could learn to get along with my mother.

TELL ME MORE ABOUT YOUR FAMILY

My mother takes care of me.

WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU

My father.

YOUR FATHER

You are like my father in some ways.
WHAT RESEMBLANCE DO YOU SEE
You are not very aggressive but I think you don't want me to notice that.
WHAT MAKES YOU THINK I AM NOT VERY AGGRESSIVE
You don't argue with me.
WHY DO YOU THINK I DON'T ARGUE WITH YOU
You are afraid of me.
DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU
My father is afraid of everybody.
WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER
Bullies.
DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE
[pages 3-4]

Astounding? We may surmise that Weizenbaum is a master computer technician and knows a little bit about how computers "think." But he is more than a technician. He is a humanist and serious social thinker. One may credit him with being in the order of a Renaissance man. He writes well. He writes specifically. And he writes with soul.

The chief problem Weizenbaum grapples with here concerns a society which is rapidly moving away from its agrarian roots in which holistic thinking, emotion, spirit, and human values are cherished; a society he perceives moving toward a machine dominated world in which artificial intelligence may come to dominance and deal human dignity a very severe black eye. Weizenbaum takes on those who champion the cause of technology over the poetry of the human spirit: the B F Skinners, the Newells, the Simons, the Schanks (mentioned in his book), and gives them a pretty good run for their money. He does it in the form of trying to find a limit to the appropriateness of computer thinking. (One may take a bit of license here and surmise that the computer is a viable symbol of technology as a whole.)

Weizenbaum is wary of the concept of artificial intelligence. He says that the expectation that computer thinking will mirror human thinking will never be fully realized. One of his most interesting arguments is that the barriers posed by natural language may well be insurmountable. Context and vocabulary pose problems that may never be handled adequately without real world human experience. Language is ripe with ambiguities as anyone who has taken the trouble to consider the question at all is well aware. Computers are notoriously unambiguous. He argues that the human experience is a shadowy one—one which can never be boxed into a logical framework and ultimately must be poorly communicated in the form of a necessarily deterministic computer program. The range and depth of human experience is unfathomable and unlimited. After reading Weizenbaum's book, I'm not quite sure exactly what programmers can program but I expect it lies somewhere in the realm of the finite.

What are the limits of computer thinking? Of technology? After reading Professor Weizenbaum's book I still don't know. The fact is that nobody knows.

Peter Travisano
Jaffrey NH■

More Resource Books

The following letter was received recently, and we print it in the book reviews section since it concerns resource materials for computer applications available in book form.

In the October issue of BYTE, Fred Bell concludes his interesting review of the Dwyer and Critchfield book, *Computer Resource Book – Algebra*, by asking if there are other computer resource books for geometry, trigonometry, probability and statistics. Here is a list of a few more, with a brief description of each:

1. Advanced Placement Calculus: Exercises with Computer Programs *by B Bates, K Jarvis and A Van Duyne, 174 pp, $5.50 (Answer Key, $1.50; Solution Manual, $5.50).*

   In addition to 600 calculus problems, this book contains 30 computer programs covering function graphing, limits and derivatives, function approximations, the definite and indefinite integral, roots and intersections, areas and volumes, curve lengths and surface areas, systems of differential equations, etc.

2. Problem-Solving with the Computer *by Edwin R Sage, 244 pp, $6.95.*

   This text teaches BASIC in the context of the traditional high school mathematics curriculum. There are 40 carefully graded problems dealing with many of the more familiar topics of algebra and geometry. Probably the most widely adopted computer text.

3. The ENTELEK Computer-Based Math Lab *by Lawrence M Stolurow, 344 pp, 8-1/2 X 11, ISBN 87567-040-7, $24.95.*

   This book contains 35 computer-assisted instruction programs for use in high school mathematics courses. Once

Continued on page 103

Continued from page 4

computer and the computer brainchild of a bunch of MIT beavers who call themselves ECD Corporation. Then there is of course the much rumored Heathkit entry into the market (again as a kit, but certainly to be exhaustively engineered and documented) and the rumors of Japanese imports aimed at the 1977 TV games market but actually consisting of general purpose computers with minimal interfaces and video output.

My "ideal" target of an under $2000 finished product machine which is complete with video interface, mass storage on dual audio cassettes, keyboard input, 8 K of memory or so, systems software in ROM and a high level language capability is well within sight. It can be purchased in kit form over the counter right now. By the end of the year, we can expect to see the fully assembled and tested versions appearing, again well under $2000 in price, and even lower for stripped down versions in mass production. The wealth of products now on or about to enter the market suggest that the appliance computer is the computer of 1977, and the desires of users are sure to support this appraisal of the market.■

U S POSTAL SERVICE

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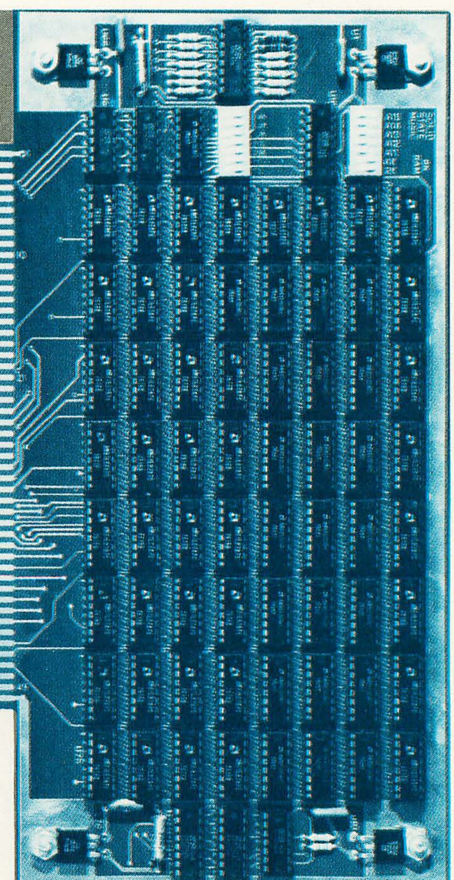
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Letters

DOCUMENTATION STANDARDS

I would like to propose some documentation standards for the distribution and publication of software for the computer hobbyist.

A source listing with self-documenting comments must be included with any software. Anyone familiar with the programming language should be able to fully understand the program by studying the source listing and comments. The source itself must also be available. If an object module is included the object module format must be completely described. A loader should be provided with a complete explanation of loading and running the software.

There are many overwhelming reasons for saying this. The hobbyist will want to study, modify, and improve the software. Others can learn programming and the principles of complex software systems such as assemblers, text editors, compilers, interpreters, and operating systems by seeing how the software works. Those who have added new or different peripherals and hardware to a system know what a task it is to patch the software without a source listing. We must also face the fact that at some time in the future the company will drop support for the software and we will be forced to fix any bugs in the software ourselves.

These documentation standards would appear to be common sense but in practice they are not in widespread use. A source listing with good documentation is more essential to software than a schematic is to hardware. I feel that it would be extremely beneficial to the growth of the computer hobby if we would all strive to meet these simple documentation standards.

James O Hamblen
3500 Greystone #218
Austin TX 78731

Most sensible. Any reasonably executed software product designed for an "experimenter" should have good documentation. If for reasons of keeping software proprietary, the code is not published, a minimum level of documentation should include a complete list of relocation information, a complete list of IO routine calling points and calling sequences for patching customer specific routines, and any other information needed to modify the software for a given system configuration.

WOW, WHAT A NEAT FORMAT

CHEERS to Laurence Krakauer *[October 1976 BYTE, page 36]* for publishing the SIMPLE way to code Morse Code in a single BYTE.

For years I have been watching people try the hard ways. Not too long ago, I saw somebody using up two bytes, one for dots and one for spaces, for each Morse character.

Notice the analogy to start-stop teleprinter operation. One sends MARK for a very long, undetermined, time. Then one sends SPACE for one bit, called a start bit, followed by the data bits. The space bit says "The character starts right after me." The space bit is then thrown away, since it is not a data bit.

Krakauer could have done it that way, by right-justifying the data bits in the byte, inserting a one for a start bit to the left of the data, and padding the remaining left bits with zeros.

His decision to left-justify the data, add a stop-bit, and pad with zeros to the right made it even easier since we operate easily on the carry flag.

In teleprinter operation, we take a two-bit penalty for start and stop bits, requiring ten bits to send eight data bits. In Krakauer's format, the start bit is unnecessary, since we know where the byte starts. He takes only a stop-bit penalty, leaving 7 good data bits.

N J Thompson
Univ of Hawaii Geophysics
2525 Correa Av
Honolulu HI 96822

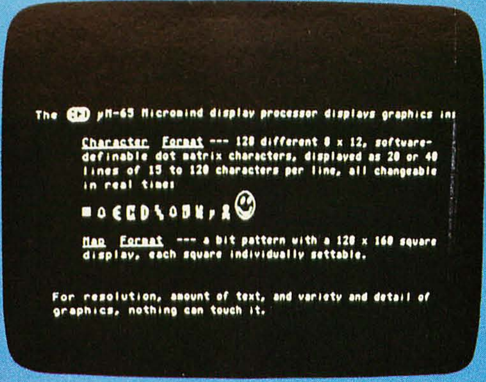
NEW COPYRIGHT LAW

I was astounded, amazed and very pleased to get the award for the Bomb Bonus Contest!!! Who would have thought of it for a paper on copyright, no less! Bless your readers!!

All I can say for the future is that perhaps this will act as a further spur for me to write some additional pieces for BYTE.

Do you know that we are getting a *new* copyright law, which will be effective on January 1 1976? Some points: It will for the first time make a magnetic tape a protectable "copy!" Also, a program in the core memory will be a "copy." The new law preempts *all* copyright rights to the federal law (previously state laws applied to unpub-

Continued on page 52

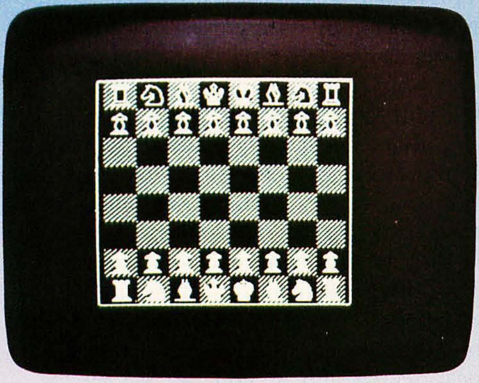


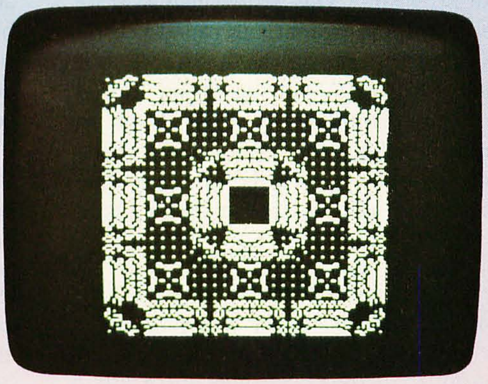
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TABLE:				
TABLE:	00	N	O	P
+4:	01	L	D	R
+8:	02	S	T	R
+12:	03	A	D	D
+16:	04	A	N	D
+20:	05	R	O	T
+24:	06	C	L	R
+28:	07	S	T	P

Figure 1: An Opcode Table Organized for Direct Access. Note that with this particular organization the first data byte of each entry is related to the address of the entry within the table, in a sorted sequence.

Making Hash With Tables

Terry Dollhoff
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Hashing is a technique used to speed up table searching operations by making position in the table depend upon the data. Many newcomers to programming reject hashing as an overly complicated technique useful only by the designer of exotic systems software, but this is not the case. Any large program, written for fun or profit, may include tasks of accessing, storing, or modifying entries in a table or array. Most game playing programs include a number of such tasks. Application of hashing techniques can often dramatically improve the performance of these programs. This article will explore the use of hashing (sometimes called key-to-address transformation) as a simple but effective mechanism for accessing stored data. These techniques can be used in applications where the data is organized randomly and where each item has a unique key associated with it. For example, consider a table that contains computer opcode mnemonics and their associated value as used in an assembler; by using the opcode value as a key this table could be used to determine the mnemonic associated with any particular value. Such a table is an integral part of any disassembler.

In any computer, a particular entry in a table can be specified by the starting address of the entry. Locating an item in a table implies that the starting address for that item must be determined. One possible method that can be used to determine the address, and by far the most common method, is to examine each item sequentially, starting with the first item, until the desired item is located and hence the item address determined. This approach is termed a linear search and as you can see by the the 8080 subroutine of listing 1, it is simple to code. The big disadvantage of a linear search is that it is costly in terms of processing time because, on the average, at least one half of the table entries must be examined before locating the desired item. If the table is moderately large and numerous accesses are required, then the table lookup processing time will constitute a significant part of the total processing time.

An alternative to the linear search involves storing the information in a sorted fashion based upon the key. However, even the best known algorithms for locating data in a sorted table require an average of Log_2 N tests, where N is the table size. Therefore, a table with, let's say, 500 entries requires an

Listing 1: Typical 8080 code sequence for a linear search of a table until the first byte of the current table entry matches the value in the accumulator. In this listing, the HL register pair must be preset to the address of the table, the DE register pair must be set with the number of bytes per table entry, the B register must contain the number of entries to search (maximum 255) and the key value sought must be loaded in A. This is by no means the only possible 8080 linear search strategy.

```
FIND:   CMP     M       Check for a match;
        RZ              If so then exit;
        DAD     D       Advance to next table entry;
        DCR     B       Decrement count;
        JNZ     FIND    Continue till end;
        JMP     ERR     Table exhausted, treat as error;
```

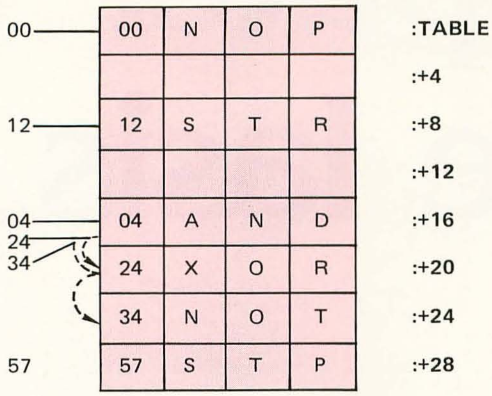


Figure 2: A Hash Accessed Table. Note that with the hash algorithm described in the text, three elements of this table map into identical starting entries, resulting in a rehash requirement indicated by the arrows and dotted lines.

average of nine tests to locate an arbitrary item. Although this is a considerable improvement over the linear search, which would require an average of 250 tests to locate an item, hashing techniques require considerably fewer tests than either method, without the added burden of sorting.

The Key

The fundamental idea behind any hashing technique is that instead of searching the table to determine the address of a particular entry, an attempt is made to calculate the address using the key. That is, a subroutine is written which, when given any desired key, calculates the table location containing the item associated with that key. If this calculation is successful, then the desired item is located with a single search.

The first step is to determine the key. This choice will depend upon the intended use of the table. In the opcode table mentioned earlier, the opcode value is the key since all lookup requests are of the form: "What is the mnemonic for the opcode X?" On the other hand, if this same table were incorporated in an assembler or compiler, then the mnemonic would be the key because requests are now of the form: "What is the opcode value for mnemonic X?". In all of our examples, we will assume that the opcode value is the key.

Direct Access Hash

Imagine that there are only a limited number of opcode values and it so happens that, although the value is eight bits long, the opcode is uniquely determined by the rightmost three bits. If a table, called TABLE, is created with eight 4 byte entries, and the mnemonic and value for each opcode is placed in the table entry whose address is found by multiplying the rightmost three bits of the opcode by four and adding the results to the base address of the table, then a simple subroutine can calculate the precise location of any entry. That subroutine, shown in listing 2 for an 8080, simply strips off the rightmost three bits of the key, multiplies them by four, and adds in the starting address of the table as shown in figure 1. Entries are added to the table in the same manner. Tables of this type are called *direct access* and are most commonly used for conversions; that is, converting from one character code to another, from opcode values to mnemonics, etc. In many direct access tables the actual key is not even stored in the table since a comparison is not necessary to determine the proper entry.

Open Hash

The direct access method would obviously break down if certain opcode mnemonics were associated with values whose rightmost three bits were equal. In this case, where direct access is infeasible, the algorithm must be slightly modified. A subroutine is still used to calculate the address, but since it is no longer possible to

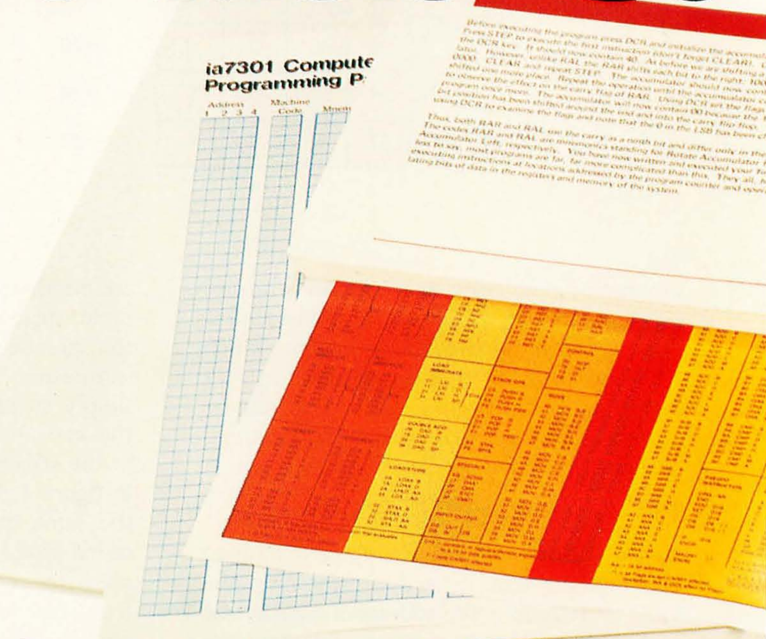
Editor's Note:

In this article, we represent several algorithms in a structured pseudo code form appropriate to the discussion. These algorithms are referenced by numbers in brackets, as in [n] for algorithm n. Each algorithm should be thought of as a formal procedure, which in practice would be called as a subroutine.

*Listing 2: Typical 8080 code sequence for direct hash with a table of eight entries, each entry being four bytes in length. In a direct hash approach, the actual data value (in this case, a number from 0 to 7) being sought is used to determine the offset in the table directly. Here the calculation is made according to the formula: ADDR := BASE + 4 * (A & 7) where A is the value of the entry being sought, BASE is the starting address of the table, and ADDR is the effective address of the table element involved.*

```
FIND:   LXI     H,TABLE     HL:=Table pointer;
        ANI     7           Extract rightmost three bits;
        RLC                 Multiply by four;
        RLC
        ADD     L           Add the table address;
        MOV     L,A
        MVI     A,O
        ADC     H
        MOV     H,A         HL:=Entry address;
        RET
```

Microcomputer pro with the Iasis Co



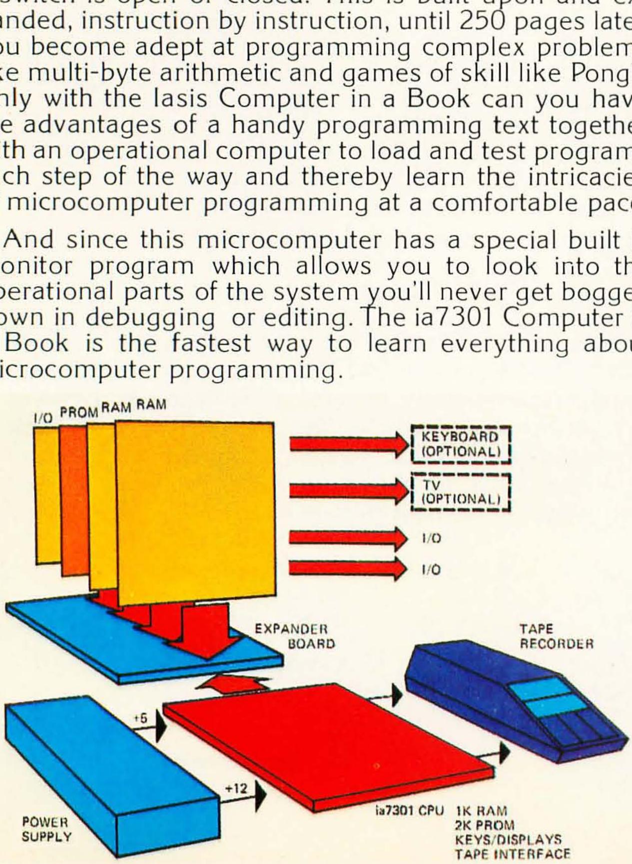
The fact is that right now microcomputer programming is a bear. Microprocessors are loaded with subtleties which make software development a long, arduous process. That's why we developed the ia7301 Computer in a Book.* It's a fully operational microcomputer system and a 250 page programming course all contained in a 3-ring binder. This is not a kit or a toy but a powerful, microcomputer system (based on the industry standard, the 8080) and a practical programming course specifically designed to quickly bring you up to a high level of understanding and proficiency in programming 8080 based microcomputer systems.

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*U.S. Patent Pending
Pong is a trademark of Atari, Inc.

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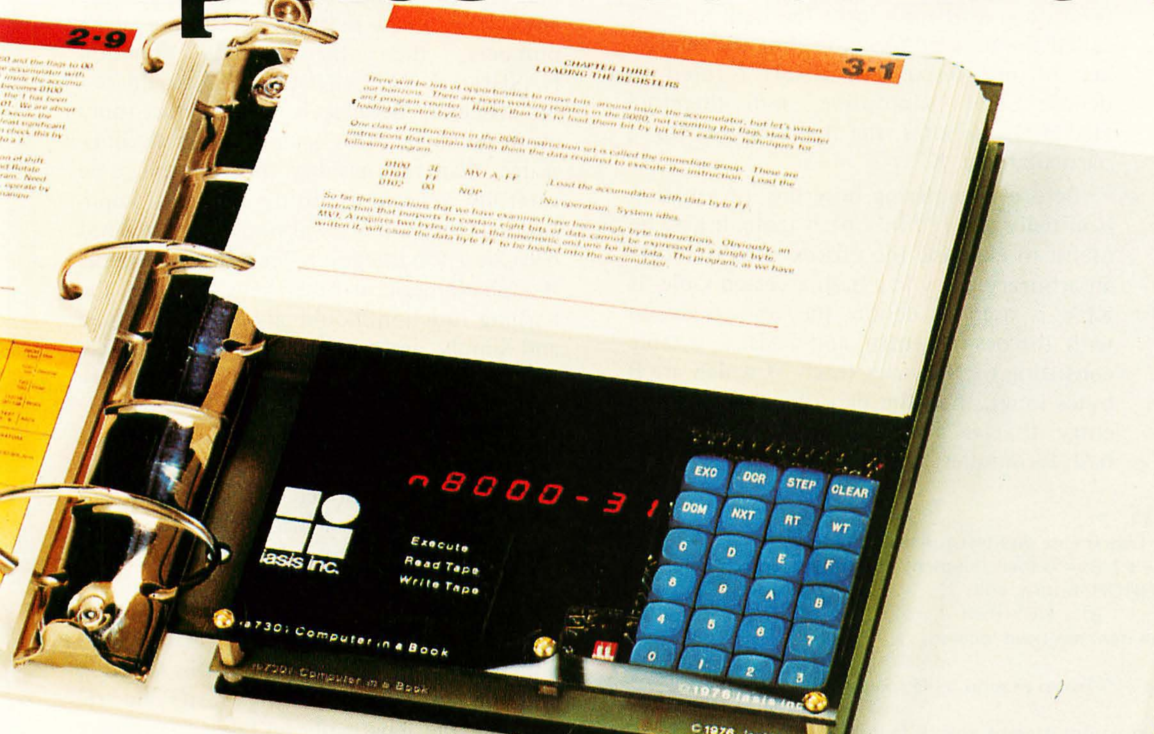
Also the write tape and read tape mode keys have been carefully designed for accurate and convenient operation with any home cassette tape recorder that has an earphone and remote microphone jack. Two LED indicator lamps tell how long it takes to dump or reload programs from the system's memory onto tape and back again. But in the reloading cycle, if any errors have occurred such as a lost piece of data, or the volume knob is too low, the readout displays will indicate errors. This little feature prevents untold problems in debugging a reloaded program.

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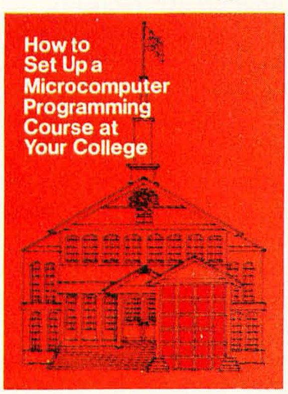


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successfully calculate the location of all entries, some type of searching algorithm must be employed to pinpoint the position of the entry, given the calculated position. The initial predicted position of the table item is called the *hash index* and the procedure which produces the hash index is called the *hashing function*. For the remainder of our discussion, HASH is used to denote that subroutine and therefore HASH(K) denotes the hash index for a particular key, K.

Before considering how the information is initially entered in a hash table, it may be useful to examine the process used to locate an arbitrary entry in a hash accessed table. If KEY is used to denote the key associated with the desired entry, and TABLE, a table consisting of N entries (each of which are B bytes long), then the algorithm to locate the entry that is associated with KEY, using hash techniques, is as follows:

```
[1]  1.  I,J := HASH(KEY);
     2.  do until (I=J—1) [worst case end test for search failure] ;
     3.      if @(TABLE + I * B) = 0 then [element not present, search failure] ;
     4.          do; call ERROR; return; end;
     5.      if @(TABLE + I * B) = KEY then
     6.          return [the item has been located] ;
     7.      I := I + 1;
     8.      if I = N then I := 0 [wrap around table space limit] ;
     9.  end;
    10.  call ERROR [element not present, search failure] ;
```

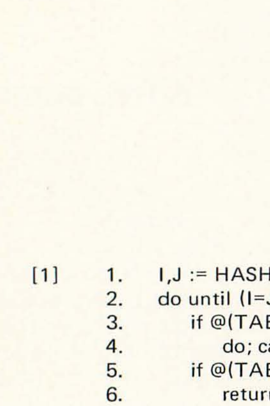


Figure 3: Folding Keys. When it is desired to retain the significance of all the bits in a key while compressing the total number of bits used, folding by some operation such as addition can be used.

In this algorithm, specified in a structured pseudo code form, step 1 calculates an initial estimate of the location of the item associated with KEY, the hash index. This value is saved in J for the worst case end test in the *do until* construct of step 2. In steps 3 and 4, the algorithm tests for a null entry end of search criterion and calls an ERROR routine if this is detected. Return to the calling program follows detection and flagging of the search failure condition. Then the algorithm tests to see if the current entry is equal to KEY at step 5; if this condition is found, the algorithm terminates with a return operation at step 6. Otherwise, the next index is calculated at step 7, an end around wrap condition is tested at step 8, and the do loop is closed at step 9 with an end statement. If the loop execution ends through the test on line 2, step 10 is reached and an error condition is flagged before an automatic return assumed after the last line of such a procedure.

Consider again the opcode table example. If the hash procedure is defined as HASH(K) = REMAINDER(K/8), then each table item shown in figure 2 can be located by at most three searches using algorithm [1].

Defining HASH

In choosing a hash function, you must attempt to define a general procedure, using a minimal number of simple computations, which produces an even distribution of hash indexes for a random selection of possible keys. If we knew that all opcodes were even numbers, then the hashing function HASH(K) = REMAINDER(K/8) would not be efficient, because it will produce only even numbers. This simple example illustrates that the hashing function must be carefully selected to suit the particular application. It should also be noted that it is not necessary for the key to be a numeric value. If alphanumeric or other keys are used, the hashing function should ignore the data type and simply perform numeric or logical manipulations of the key as though it were numeric.

One of the most widely utilized, and historically the first, hashing function has already been mentioned. If N is the size of the table (in terms of the number of entries, not the number of bytes) the hash index is the remainder of the key divided by N. More precisely stated, HASH(K) = REMAINDER(K/N). In a machine such as the 8080 which lacks division capability, this function will be made significantly faster by restricting the length of the table to a power of two (ie: $N = 2^M$). If $N = 2^M$, then the REMAINDER (K/N) also happens to be the rightmost M bits of K and a divide operation is no longer required. The remainder is selected by a logical AND operation.

The remaindering function will not produce well distributed hash indexes if many of the entries end with the same bit sequence. This situation is frequently encountered when dealing with alphanumeric data. Changing the table size to a prime number usually improves distribution, but now we are back to the unwanted divide operation for calculating the remainder. There are two other alternatives to this problem. The first is a technique called *folding* as diagrammed in figure 3. This method applies the remaindering algorithm to the bit string that is obtained by adding the upper half of the internal binary representation of the key to the lower half. This minor improvement minimizes the effect of patterns that may occur within the key. You should be careful what improvisations are made to the folding technique. For example, substituting a logical AND for the add sounds good, but will merely make matters worse. If in doubt, try experimenting with various keys by examining the effects of key

value in a test program to grind out hash indices.

A second method for minimizing the effect of similar bit patterns in the key, best applied to tables of size 2^M, is called *squaring*. This consists of selecting the center M bits of the number that is obtained by multiplying the key by itself. Since the middle bits of the product depend upon all of the bits in the key, this method generally produces a uniform distribution of hash indices.

Since the squaring method is safest, it may appear that one should always use it. This is certainly not the case because the purpose of hashing is to save processing time and although squaring is the most general technique, it is unfortunately the slowest since it relies on a multiply operation which the 8080 and most other small processors lack. It is often acceptable to settle on a slightly less efficient hash function if such a function is substantially faster. The guideline for selecting the hash function is to employ a more complex function only in those specific cases where a simple function fails to produce an adequate distribution of hash indices. But remember, any hash function is better than a linear search. Why? A linear search is a hash access where HASH(K)=0 for all values of K, therefore any distribution is better than none. This degeneracy is evident in algorithm [1] when the data item sought is not in the table, and the algorithm searches every location.

Multibyte Hash

Until now, we have tacitly assumed that the entire key can be contained in one byte. This is impractical, and the hashing concept is easily extended to cover those cases where the key occupies more than a single byte. If the key is continued in byte locations (K_1, ... K_j) then a multibyte hash function, HASHM, can be defined in terms of any of the previous hash functions as HASHM(K,J) = HASH(K_1+ ... +K_j). That is, any of the single byte hash functions are applied to the sum, ignore carry, of the bytes in the multibyte key. As you see in figure 4, this is similar to the folding technique just mentioned.

Another possibility for a multibyte hash, which should be used with some degree of caution since it may not provide an even distribution, is to apply a single byte hash function to the last byte (or any other byte of your choosing) of the multibyte key. This eliminates the time required to add the words of a multibyte key. As usual, the programmer is faced with a time versus efficiency tradeoff.

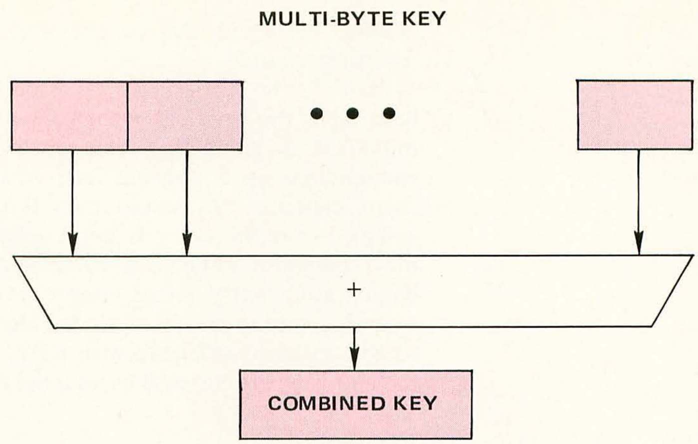


Figure 4: The principle of folding key elements can be extended to a multibyte key. The multibyte hashing scheme might be employed where a key is a character string field.

Guidelines

In summary, the sole purpose of a hashing function is to calculate an initial table index for a linear search, given a specific key. There is no one best algorithm and the number of algorithms available is bounded only by your imagination. The general guidelines to follow when designing your hashing function are:

1. Keep it simple – Remember, the goal is to locate an item in the minimum amount of time. If the perfect hash requires more time than a linear search, it is useless!
2. Insure an even distribution; beware of weird bit patterns in the key.
3. Check out the operation of the function prior to employing it as a hash function. There is often an overwhelming urge to give it the smoke test, but hash indices are used to form memory addresses so it may be difficult to isolate bugs in the hash function after you've incorporated it into a table lookup procedure. Save yourself some time, check the table lookup subroutines first.

Building the Table

Obviously, for the hash access algorithm to operate smoothly, the table items must have been entered into the table properly. The relative ease with which entries can be made in a hashed table is an important advantage of hash techniques. Remember, even though a sorted search is reasonably efficient for locating an entry, the entire table must be sorted before any access is allowed. Thus, if accesses were to be intermixed with entries, the algorithm would be

grossly inefficient due to the amount of resorting required.

Before any entries can be made in the hash table, the key field of the table must be initialized to some flag value which is not encountered as a possible key. If a table entry contains this value, then it can be assumed that the entry is unoccupied. The most common value used to designate an empty table entry is the integer zero, and assuming this to be the case, the algorithm to add an item associated with KEY, to the table of N entries (each B bytes long) is:

[2]

```
I,J := HASH(KEY);
do until (I=J—1) [worst case end test for search failure];
   if @(TABLE + I * B) = 0 then
      do;
         [enter the item at (TABLE + I * B)];
         return;
      end;
   I := I + 1;
   if I = N then I := 0  [wrap around table space limit];
end;
call ERROR [no room left in table];
```

Notice that the lookup algorithm [1] and the entry algorithm [2] are very similar in nature. The loop control is identical, and the only difference is in the actions taken. It is quite possible to make an automatic entry occur whenever a key is not found as indicated by a null key value found during a search. The following algorithm combines both operations.

[3]

```
I,J := HASH(KEY);
do until (I=J—1) [worst case end test for search failure];
   if @(TABLE + I * B) = KEY then
      return [the item has been located];
   if @(TABLE + I * B) = 0 then
      do;
         [enter the item at (TABLE + I * B)];
         return;
      end;
   I := I + 1;
   if I = N then I := 0 [end wrap around table space limit];
end;
call ERROR [if this point is reached, table is full];
```

TABLE:	00
+1:	N
+2:	O
+3:	P
+4:	01
+5:	L
+6:	D
+7:	R
+8:	02
+9:	S
+10:	T
+11:	R
.	.
.	.
.	.
+28:	07
+29:	S
+30:	T
+31:	P

Figure 5: Horizontal Organization of Tables. In this method of organization, all the bytes of a data entry are assigned to contiguous addresses.

In addition to adding or locating entries, it may also be necessary to delete entries. To delete an item, you might think that we could merely locate the item and then set the table entry to zero, thus making it available for future entries. However, if that approach were taken, not only would the desired entry be deleted, but other entries might be made inaccessible. The reason that other entries would be lost is that the searching terminates when an unused location is found. As an example, setting the entry at (TABLE + 20) in figure 2 to zero would also make the entry at (TABLE + 24) inaccessible. Therefore, an alternate scheme must be used to delete entries.

The first step is to select a deleted entry flag that is distinguishable from the unused entry flag and is also not allowable as a key.

% Items Occupied	Linear Search	Sorted Search	Hash Access Method With Rehash Indicated Below			
			Linear	Random	Day's	Wt Inc
10%	25	5.6	1.1	1.1	1.1	1.0
50%	125	7.9	1.5	1.4	1.4	1.4
75%	187	8.5	2.5	2.0	2.0	1.9
90%	225	8.8	5.5	2.8	2.7	2.5

Table 1: Comparison of Table Access Methods. This table gives the results of an experiment with random data to test out the various methods of access. The tables were filled to the percentage levels indicated at the left. A table size of 500 possible entries was used. The access methods shown are described in text.

Then, whenever an entry is to be deleted this new value replaces the entry. The new flag indicates that the entry is available for future additions to the table but does not terminate a search operation. If 0 is used to denote an unused entry and −1 is used to denote a deleted entry, then the complete hashing algorithm is:

[4]
```
1.  I,J := HASH(KEY);
2.  do until (I=J−1) [worst case end test for search failure];
3.      if @(TABLE + I * B) = KEY then
4.          do;
5.              if [entry is to be deleted] then [delete the entry]
6.                  @(TABLE + I * B) := −1;
7.              return [item has been located ];
8.          end;
9.      if @(TABLE + I * B) = 0 then [this is a null entry so]
10.         do;
11.             [enter the item at (TABLE + B * I)];
12.             return;
13.         end;
14.     I := I + 1;
15.     if I = N then I = 0 [end wrap around table space limit];
16. end;
17. call ERROR [if this point is reached, table is full];
```

This algorithm either locates an item or adds the item to the first available location. If an item is to be deleted it is first located and then the key field of the table entry set to −1.

Collisions

A *collision* occurs whenever HASH(KEY1) = HASH(KEY2), but KEY1 ≠ KEY2. As discussed earlier, a good hashing function will avoid this condition, but the problems caused by collisions cannot be ignored. Note for example that the hash index for opcodes 04, 24 and 34 in the table shown in figure 2 is 4 and hence these entries collide.

What happens when two entries collide? The only solution we've discussed thus far is to search the table, in a circular fashion, from the point of impact as in algorithms [1] to [4]. If, in general, a collision occurs, then the resulting search, good or bad, is called a *rehash*. The process mentioned above, namely, searching the table in a circular fashion from point of impact, is called a *linear rehash*, and as you might expect falls into the bad category. Other more efficient algorithms will be discussed later.

If we denote the rehashing algorithm by REHASH, then the general hashing lookup algorithm may be restated in its final form:

[5]
```
I,J := HASH(KEY);
K := 0;
do until (REHASH(I,J)=J) [worst case end test for search failure];
    if @(TABLE + I * B) = KEY then [we have a match so]
        do;
            if [entry is to be deleted] then [delete the entry]
                @(TABLE + I * B) := −1;
            return;
        end;
    if ((K=0) & [deletion or null element @(TABLE + I * B)]) then
        K := I [save last available table entry index];
    if @(TABLE + I * B) = 0 then [this is a null entry so]
        do;
            [enter the item at (TABLE + B * K), next available slot];
            return;
        end;
    I := REHASH (I,J) [REHASH results in 0 ≤ I ≤ N where N is table size];
end;
call ERROR [if this point is reached, table is full];
```

TABLE:	00	BYTE0
+1:	01	+1
+2:	02	+2
+3:	03	+3
+4:	04	+4
+5:	05	+5
+6:	06	+6
+7:	07	+7
+8:	N	BYTE1
+9:	L	+1
+10:	S	+2
+11:	A	+3
+12:	A	+4
+13:	R	+5
+14:	C	+6
+15:	S	+7
.	.	
.	.	
.	.	
+24:	P	BYTE3
+25:	R	+1
+26:	R	+2
+27:	D	+3
+28:	D	+4
+29:	T	+5
+30:	R	+6
+31:	P	+7

Figure 6: Vertical Organization of Tables. In this method of organization, a multibyte table element is treated as "n" single byte subtables where "n" is the number of bytes in each entry. Each of the "n" subtables has a length (in bytes) equal to the number of elements in the table.

The linear rehash that we've been using implicitly in [4] as steps 14 and 15 is described as REHASH(I) = (I+1)[mod N], where (I+1)[mod N] means that if (I+1) is greater than or equal to N, then N is subtracted from the value (I+1). This insures that the table is searched in a circular manner. The operation X[mod N], called X modulo N, is used in most rehashing algorithms to limit the range. Mathematically, it is the remainder of X/N; but whenever we

use X[mod N] it can be calculated as described above (ie: subtract N if X is greater than or equal to N). Here again we have avoided the use of a divide operation to provide a more efficient function.

Improved Rehash

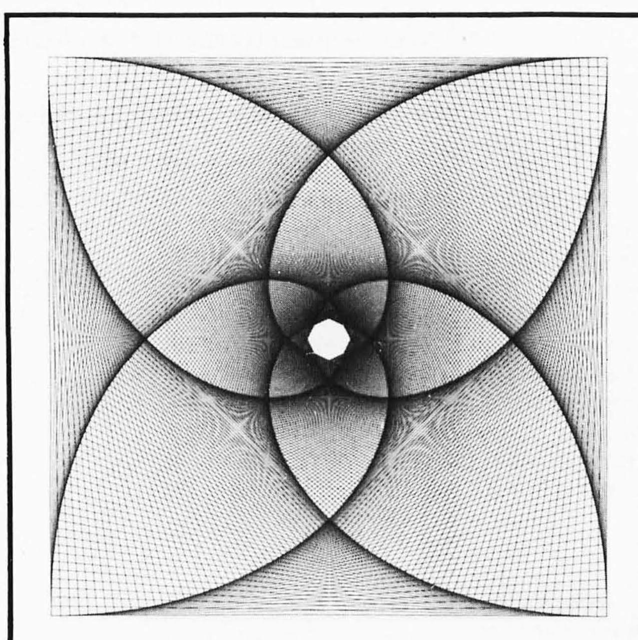
The problem with the simple linear rehash is that the table will not fill uniformly. This condition is referred to as *clustering* and causes an increase in the average number of tests required to locate an item in the table. As an example, a cluster can be seen forming at TABLE+16, +20, and +24 in the table shown in figure 2.

There are a number of nonlinear algorithms which perform the rehash function without causing the clustering problems mentioned above. Although the computer science literature abounds with such algorithms, a majority of them fall into one of three classes. An attempt has been made to select the simplest and best from each class and present them here.

Pseudorandom Rehash

The first class of rehashing algorithms is the *pseudorandom* rehash and is based upon a pseudorandom number generator. The pseudorandom number generator used is not important, but it must be of the nonrepeating variety. That is, it must generate all possible values before any previous value is repeated. It must also generate all of the integers in the range 0, ..., N where N is the table size. The following simple procedure incorporates a common random number generator and will perform the rehash function for any table of size $N = 2^M$. The variable R is internal to the rehashing function, but it must be preset to one whenever the function HASH is initiated (ie: step 1 of algorithm 5).

Art by Stephen J Rogowski



```
[6]   REHASH (I,J):
      1.    R := REMAINDER (R*5 / N*4);
      2.    REHASH := (R/4 + J) [mod N];
```

If you're seeking the most efficient implementation of this one, the REMAINDER(R*5/N*4) is just the rightmost M+2 bits of R*5 because $N=2^M$ and $4*N=2^2*2^M=2^{M+2}$. Furthermore, the divide operation in step 2 can be replaced by a right shift of two positions. Finally, if you think of R*5 as R*4+R, then it's easy to see how to reduce that multiply operation to left shift and addition operations.

Let's look at the sequence generated by this rehash routine. If our table is eight entries long and the initial hash index is, let's say, 4, then R takes on the values 1,6,7,4,5,2,3,1, so the table would be searched in the order 4(initial index), 5,2,3,0,1,6,7. How does this avoid the clustering situation? If we chose another initial index, say, 5, then the table is searched in the order 5(initial index),6,3,4,1,2,7,0. As you see, the entry searched after entry 5 will depend upon the initial index. If the initial index was 4, then 2 is searched after 5; but if the initial index was 5, then 6 follows 5. In a linear search, 6 always follows 5. This dependence upon the initial index is what avoids the clustering.

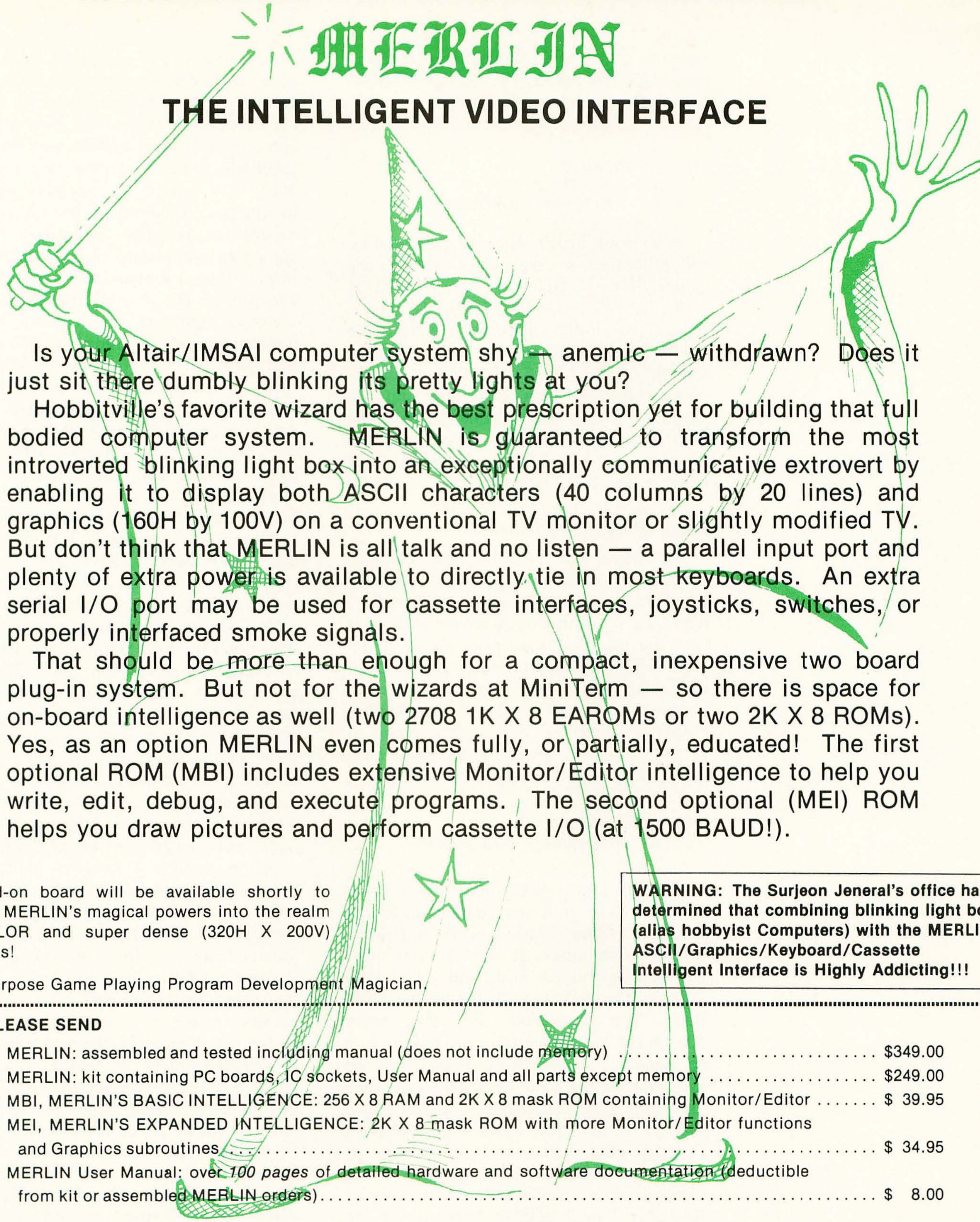
Quadratic Rehash

A second class of algorithms for rehashing is the *quadratic* rehash and these are based upon a quadratic function. The major drawback with most algorithms in this class is that they search only one half of the table, so two different rehashing algorithms are required. The most efficient quadratic rehash, and one which does search the entire table, was first introduced by Colin Day *[see bibliography, reference 1]*. Day's algorithm can only be applied to a table whose size is a prime number that produces a remainder of 1 when it is divided by 4 (eg: 5=4*1+1, 401=4*1+1). At first glance, this appears to place a great many restrictions on the allowable size of the table; but don't despair, because experience will show that a number satisfying the required condition can be found very near any desired value. Be certain that you use an acceptable number or the procedure will not search all locations of the table. Like the last rehashing function an internal variable is used. The variable, R,

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must be preset to (−N) whenever the function HASH is called. The quadratic rehash process is (remember that the mod operation is just a conditional subtraction):

```
[7]   REHASH(I,J):
      1.    R := R + 2;
      2.    REHASH := (I + /R/ ) [mod N] ;
```

If we look at the sequence generated by this procedure, we see that R takes on the values (for a table of size 11=4*2+3) −11,−9,−7,−5,−3,−1,1,3,5,7,9,11. Therefore, if the initial index were 4 the table would be searched in the order: 4(initial index), 2,9,3,6,7,8,0,5,1,10. One major difference between this algorithm and the random rehash is that this one calculates the next index based on the previous one. The random rehash calculates the next index based on the initial index.

Weighted Increment Rehash

The last, and probably the simplest, method for performing the rehash is called a *weighted increment [see bibliography, reference 2]*. This one is unique because it uses the hash index to calculate an increment which is in turn used to step through the table. The table size is again restricted to a power of 2, and whenever the function HASH is called, the variable R is preset to (2*J+1)[mod N], where J is the initial hash index. The weighted increment method is:

```
[8]   REHASH(I,J):
      1.    REHASH := (I+R) [mod N] ;
```

This process is very much like a linear rehash. In fact if R were always set to 1 it would be a linear rehash, however R depends on the hash index. If our table is eight entries long and the initial index is 5 then R=2*5+1[mod 8]=11−8=3 and the table items are searched in the order 5,0,3,6,1,4,7,2. Since the increment is a constant for any particular hash index, we can improve the basic hash algorithm when using this rehash technique. You will notice that all memory references are of the form (TABLE+I*B), where B is the number of bytes. We can avoid that multiply by including it in the computation of R. If we let R=((2*J+1)[mod N])*B, then all of the table references become (TABLE+I). If we also initialize I to TABLE+HASH(KEY) we can make all references as just (I).

Laying Doubts to Rest

You might conceivably ask, "What is gained by using a complex rehashing function?"; or if you're one of the more cynical observers, "Why use hashing at all?". In an attempt to answer these questions, a simple experiment was performed. First a table of approximately 500 entries was filled with randomly generated entries and then each entry was located in the table using the lookup technique under test. This simple experiment provides an insight into the comparative efficiency of table lookup algorithms. Table 1 summarizes the results of the experiment. This data clearly illustrates that there is significant improvement in table lookup time when hashing is utilized. Furthermore, when a complex rehashing algorithm is incorporated in the search procedure, the statistics are again improved. It is worth noting again that, although the number of tests for a sorted table is not tremendously large, the approach is very inefficient if the table must be accessed before being filled with entries.

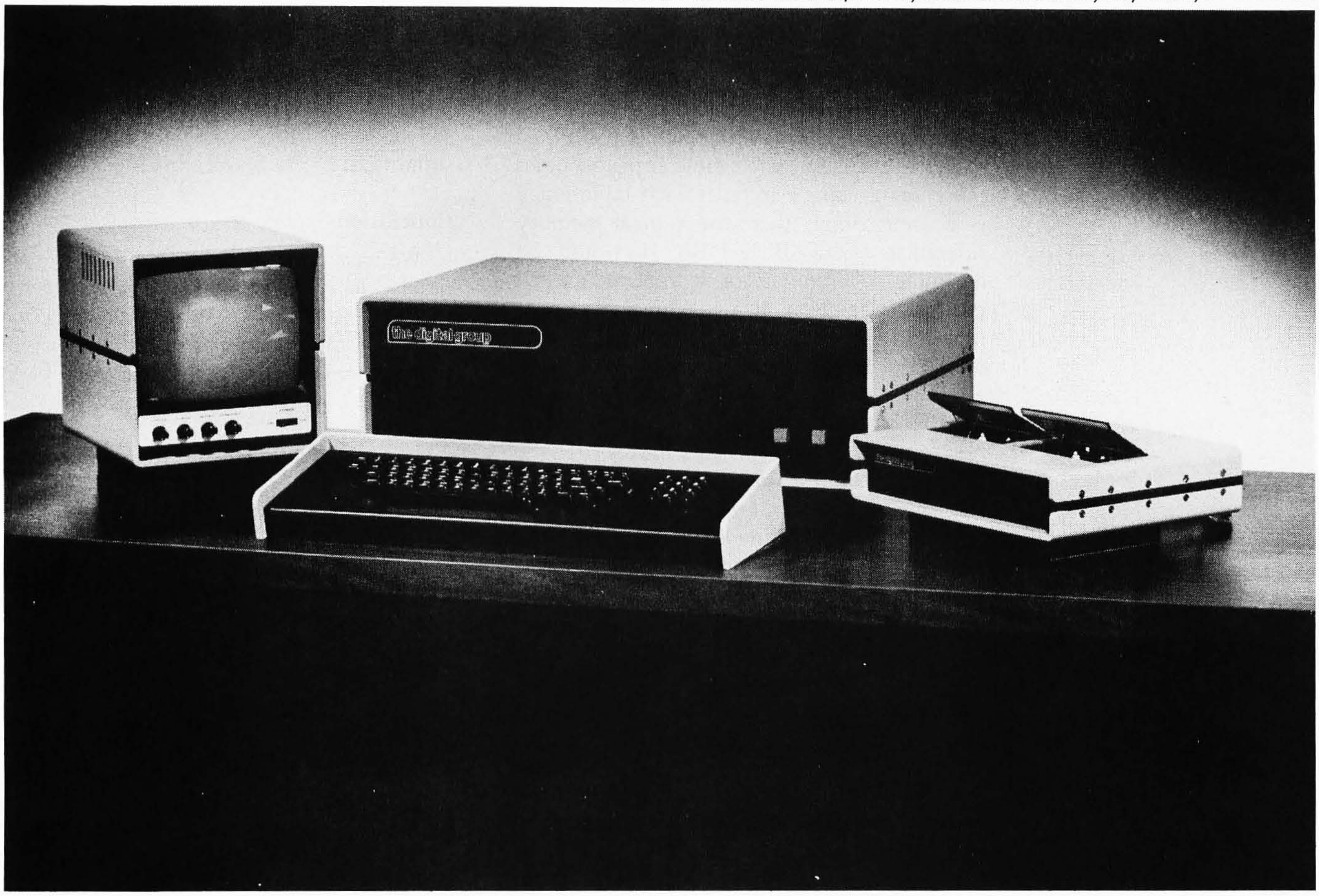
One other surprising fact about the average search length (the number of tests required) for hash accessed tables is that it does not depend upon the length of the table. Rather, the search length depends only upon the load factor or the percentage of occupied items in the table. This means that you can expect the average search time for a table of size 10,000 to be about the same as the search time for a table of size 500! This is surely not the case with the linear or sorted search. While the average linear search length skyrockets to 4,500 (for a 90% full table of size 10,000), the average hash search length remains at less than six!

Although table 1 seems to indicate that the weighted increment is most efficient, we must be careful not to read too much into these results. The statistics in table 1 were obtained using randomly generated keys in the test program. When actual keys are used the search statistics will vary somewhat because actual keys are rarely perfectly random. For example, the search length for a weighted increment search is adversely effected by bit patterns in the key. The best way to insure that you are using the most optimal search procedure is to repeat the experiment with a sample of actual keys. If a finely tuned algorithm is not important, then the weighted increment is probably the better choice because it is simple and can be applied to any format of table. As we will see shortly, most of the algorithms work best if the table is rearranged in memory.

Application

There are a number of "tricks" which can be used to improve efficiency. A number of

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them have already been mentioned. One approach not discussed so far is table reorganization. Throughout our discussion we have assumed that each table entry occupies more than a single byte. If each table entry is B bytes long, then the typical memory reference is (TABLE+I*B). It would be desirable to eliminate or at least reduce the multiply operation. If a weighted increment rehash is used: We already discussed how to eliminate the multiply. Another method to eliminate a multiply is table reorganization.

All of the tables discussed so far were horizontally organized. This means that the items are stored as shown in figure 5. This is the most common table organization. An alternative organization is a vertical organization such as in figure 6. If you have organized your table vertically then the first byte of an item is addressed by (TABLE+I) and the multiply is gone. All of the other bytes in the item are addressed by (BYTEN+I) where BYTEN is the address of the nth byte of the first item. Thus by organizing the data vertically we eliminate a multiply operation. This vertical arrangement is practical from other aspects also. Consider searching the table for all items containing a specific value in the third byte. Since the third byte of each item is stored sequentially this search operation is simplified.

Conclusion

We have tried to show that hashing is not nearly as complicated as you might have thought. By using these techniques perhaps you can regain a valuable slice of your microprocessor's processing load.■

BIBLIOGRAPHY

1. Day, Colin A, "Full Table Quadratic Searching for Scatter Storage," *Communications of the ACM* 13,8 (August 1970), pages 481-482.
2. Luccio, F, "Weighted Increment Linear Search for Scatter Tables," *Communications of the ACM* 15,12 (December 1972), pages 1045-1047.
3. Morris, Robert, "Scatter Storage Techniques," *Communications of the ACM* 11,1 (January 1968), pages 38-44.
4. Dollhoff, Terry, "Hashing Methods for Direct Access Files," Auerbach Computer Programming Management, Folio 15-02-02.

GLOSSARY

Clustering: Grouping of elements within a table caused by equal hash indices.

Collision: Two elements with the same hash index.

Direct access hash: A hash algorithm which precludes collision. That is, no two elements have identical hash indices.

Dissassembler: A program to translate object code to assembly language. Inverse of an assembler.

Folding: Procedure for randomizing the hash index. The upper and lower half of the key are added together before the index is calculated.

Horizontal table: A table whose entries are stored sequentially. That is, (entry one, byte one), (entry one, byte two), etc.

Hash index: The initial estimate of the location of an entry within the table.

Hashing: A nonlinear algorithm for storing/retrieving data from a table.

Hashing function: The algorithm or procedure for calculating the hash index.

Key: Field within an entry that is used to locate the entry. For example, surnames are the key field of the entries of a telephone directory.

Linear rehash: A method for resolving collisions. The table is searched sequentially from the point of impact.

Linear search: Table search which examines each item starting with the first item and proceeding sequentially.

MOD: Remainder of one number divided by another. That is, X MOD Y is the remainder of X/Y.

Pseudorandom rehash: A method for resolving collisions. A nonrepeating random number generator is used to determine the next entry to be searched.

Quadratic prime: A prime number which produces a remainder of 3 when divided by 4.

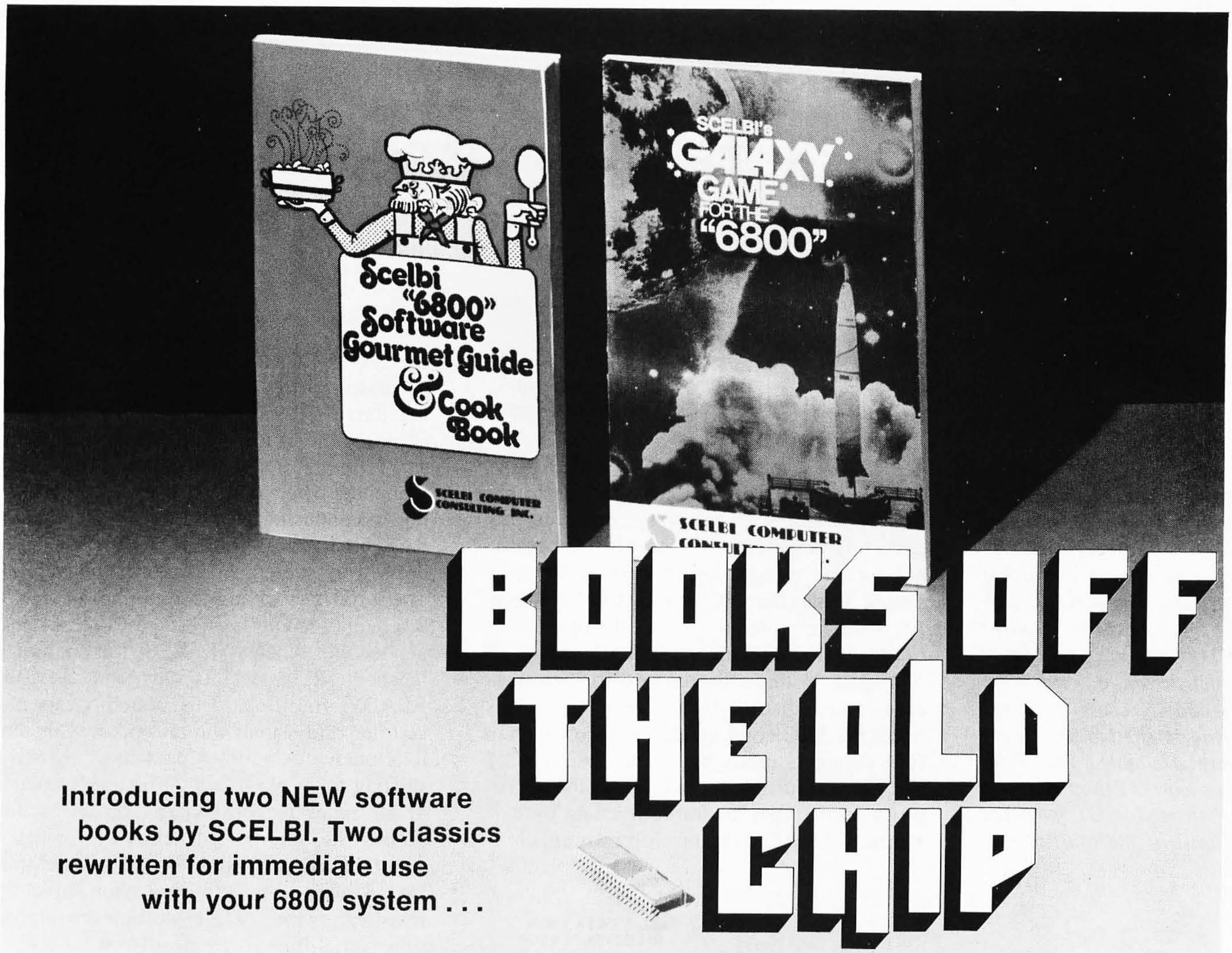
Quadratic rehash: A method for resolving collisions. A quadratic or second degree function is used to determine the next entry to be searched.

Rehash: Any algorithm for resolving collisions.

Squaring: Procedure for randomizing the hash index. The key is multiplied by itself before the hash index is computed.

Vertical table: A table where the bytes of each entry are stored sequentially. That is (entry one, byte one), (entry two, byte one), etc. FORTRAN stores arrays in this manner.

Weighted increment rehash: A method for resolving collisions. The hash index is used to determine the next entry to be searched.



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How to Drive a Teletype Without a UART

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This parallel to serial converter performs functions similar to any other; however, this circuit is designed with the microprocessor hobbyist in mind. This conversion design is simple and extremely easy to trouble shoot. All the logic involved is out in the open, so it can be examined with an oscilloscope.

Figure 1 shows the circuit. In the quiescent state, the READY line is high. This holds the 7493 counter, IC1, at zero which in turn connects input E_0 to the output W of the 74150 multiplexer IC2. When the microprocessor is ready to transmit a data byte, it samples the READY flip flop output, pin 5 of IC4. If READY is high, then the microprocessor writes the ASCII character into the data 74199 register, IC3, and resets the READY line. A low READY line enables the 7493 counter, IC1, which addresses the bits in sequence. Upon the first count, the start bit E_1 is connected to the output. The eight data bits and two stop bits are then addressed by subsequent states of the counter. The 110 Hz clock produces a transfer rate of 9.09 milliseconds per bit or 10 characters per second. When state 12 of the counter is reached, IC5a detects this and sets the READY flip flop. This action clears the counter and signals the microprocessor that it is ready for another data byte. No serial shifting takes place and all bits are available at all times for observation on an oscilloscope. As shown, this circuit provides a standard asynchronous format of one start bit, 8 data bits and two stop bits. By reassigning the 74150 multiplexer inputs, other serial formats are possible.■

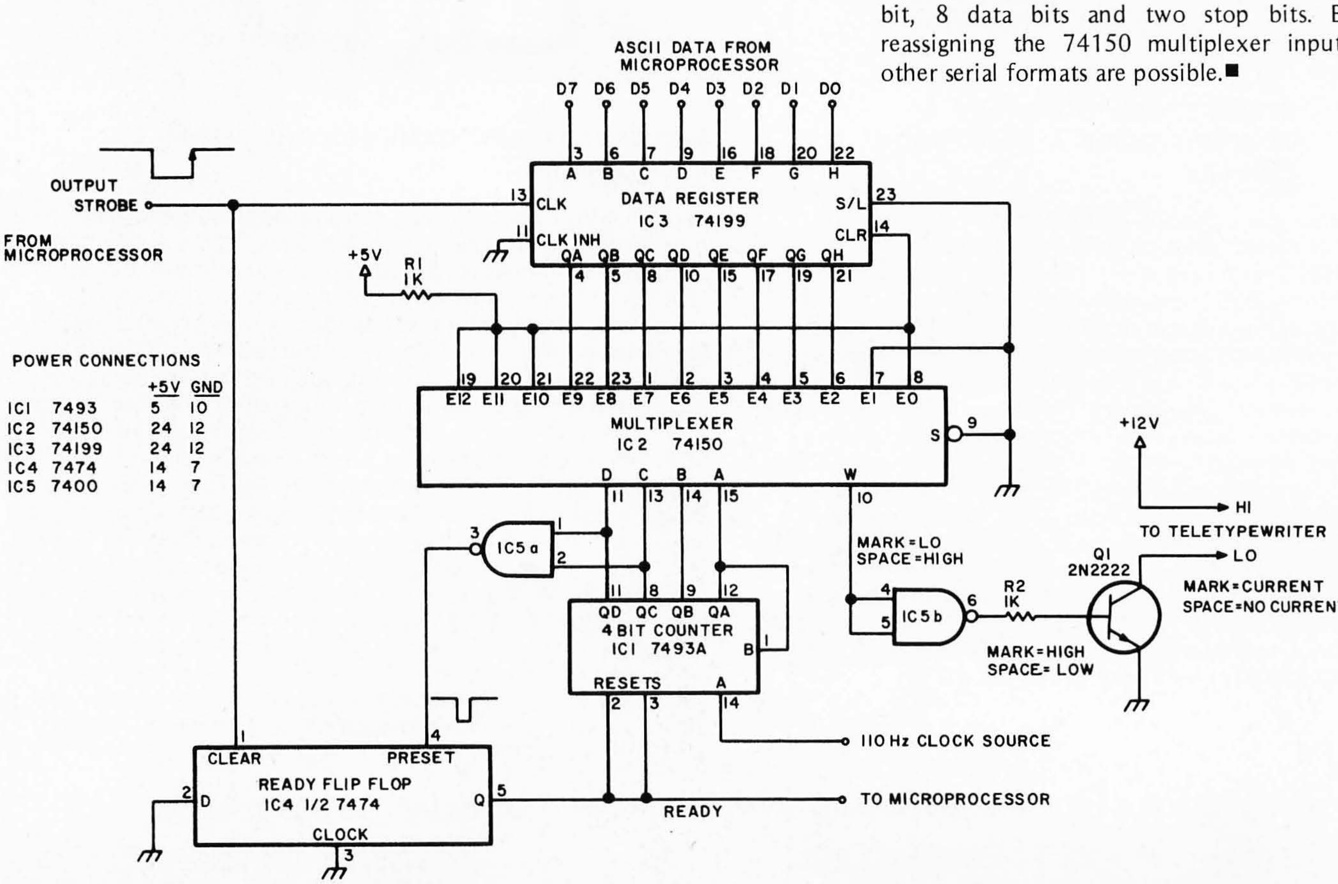


Figure 1: Parallel to Serial Conversion Schematic. The multiplexer IC2 is used to select formatting and data bits according to the state of the counter IC1. IC3 is an output latch which would not be needed if access to an existing latched output port were available. The Teletype current loop is driven by transistor Q1 from the output of the multiplexer.

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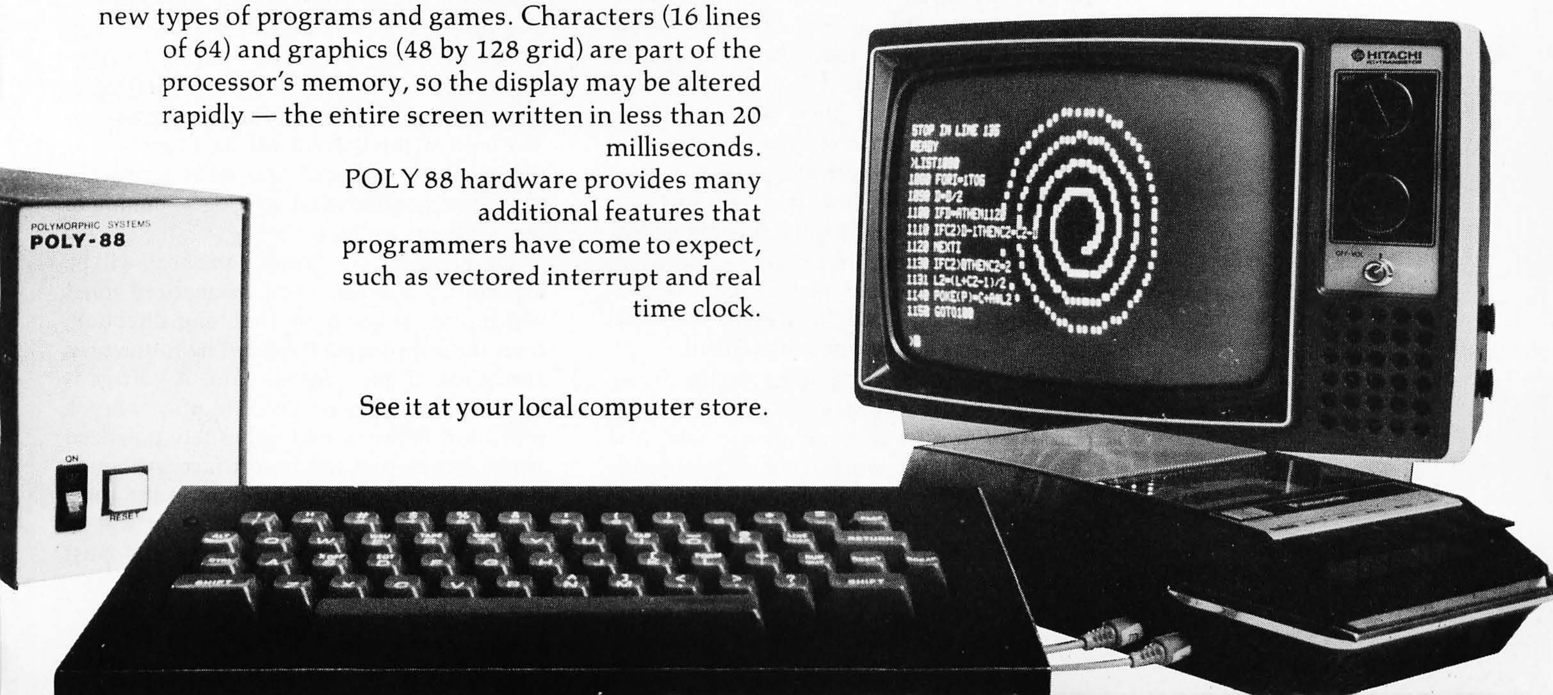
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Saturation Recording's Not All That Hard

David M Allen
Electronics Consultant
1317 Central Av
Kansas City KS 66102

The cassette recorder is doubtless the most common and popular peripheral device among hobbyists, and considerable attention has been paid to its employment. Almost all of this attention has been directed toward the use of unmodified audio recorders. This complicates a simple problem. Saturation recording is the logical way to store digital data on tape, so why use audio? Saturation recording is more straightforward, more flexible, and inherently more reliable. The design presented here uses only a few garden variety integrated circuits; no PLLs, no UARTs. It presupposes no encoding scheme, so the user is free to pick and choose among the various techniques available. I used ordinary NRZ (Non Return to Zero) ASCII because it was easiest to write software for. The hardware in this design is extremely simple; software is used for encoding and decoding as well as the serial to parallel and parallel to serial conversions. Where hardware versus software tradeoffs were available, software was used since integrated circuits cost money and require test equipment to insure that they work properly. Software can be free (depending on who writes it) and thus where budgets are tight or flexibility desirable, the trade of software for hardware comes highly recommended. This is the so-called "intelligent" approach, and this interface was in fact employed in the construction of an "intelligent" terminal which I use as a Teletype replacement.

The cassette recorder used in the prototype system was a genuine "El Cheapo," purchased for $5 at a warehouse sale. The electronics didn't work, but in this design the electronics are not used anyway .... only the head and motor are used and must be in good condition.

The Pragmatics of Saturation Recording

During recording (or "writing"), only a single signal is impressed onto the magnetic medium; there is no carrier, nor bias signal. The signal itself, at any given instant, will be in one of two states: full positive or full negative. Note that while the digital data may be discussed in terms of ones and zeros, it is written on tape as +1s and −1s where the value 1 refers to saturation of the magnetic medium *[see BYTE, March 1976, page 18]*. To accomplish this in a cassette recorder, it is necessary only to pass a small direct current through the winding of the combined record and playback head. Polarity of the saturation recorded signal (+ or − 1) will be determined by the direction of current flow through the head winding. The magnitude of the recorded signal will be that corresponding to saturation of the magnetic medium, and is achieved by passing enough current through the head winding to guarantee that the medium will be magnetized as much as it is capable of being magnetized. The level of this current will be a function of the magnetic material and head characteristics, but is noncritical so long as minimum requirements are met.

On playback (or "read") the head will be exposed to a series of tiny magnetized zones which are oriented in first one direction, then the opposite, corresponding to the ones and zeros of the original data. A voltage is induced in the head winding only when a transition between two oppositely polarized zones moves past the head's face. Although the data resides on the medium in the form of zones of constant magnitudes, it will be sensed in the form of transitions, and must

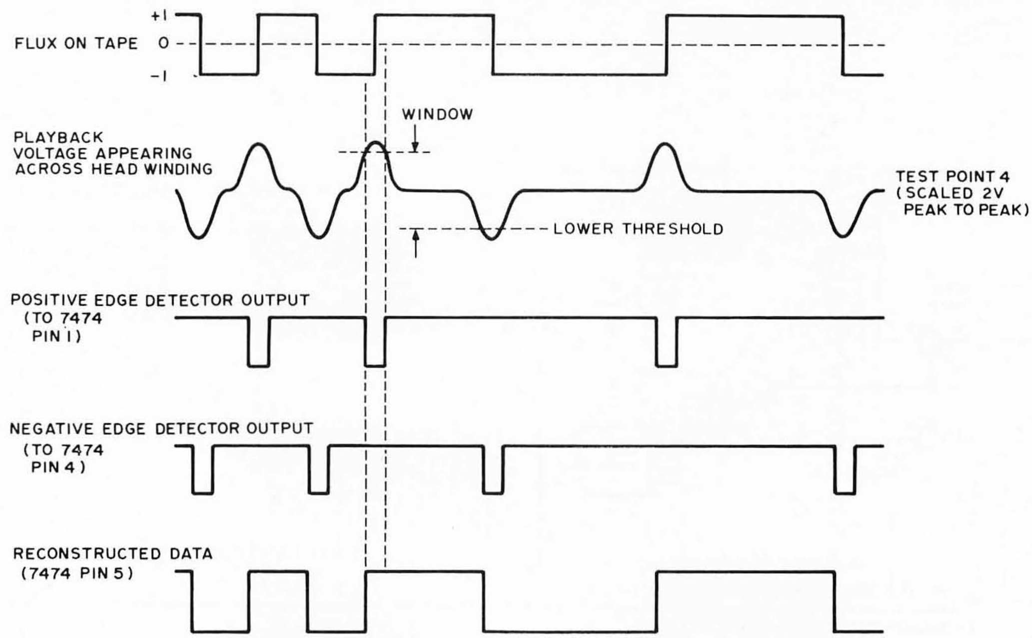


Figure 1: Timing of a Direct Digital Read Operation. The flux on the tape is shown at the top as an idealized square wave. The playback voltage is second from top, an analog function which reflects the actual tape flux zones and the sensing of these zones through the tape head. Referring to the schematic of figure 3, the positive going and negative going transition edges are detected and used to produce pulses which drive the 7474 flip flop used to reconstruct data as received. This data out of the 7474 is read and decoded by the adaptive software running in the processor.

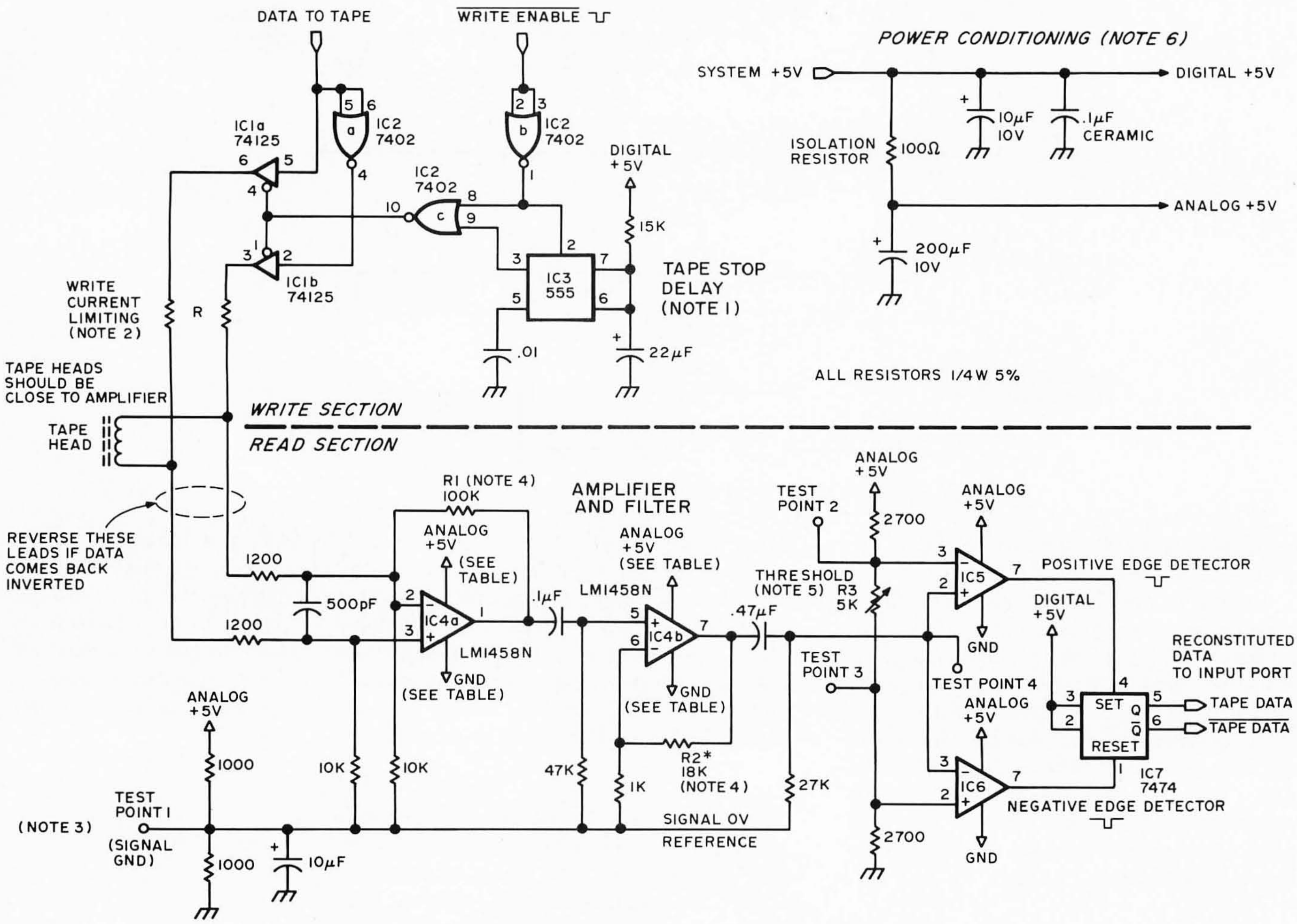
be reconstructed if it is to resemble the original data (see figure 1).

Erasure of old data does not necessitate a separate erase head, since erasure is inherent in the recording of new data at saturating levels. In some applications a separate erase head may be desirable to prevent the occurrence of unerased gaps due to starting and stopping the tape motion between blocks of data, but this was accomplished in the prototype without the need of an erase head. Little need is seen for an erase head in simple applications.

Hardware Design

The hardware required to write data onto tape is indeed trivial. The only tricky aspect is figuring out how to switch the direction of the write current without resorting to discrete components and a negative power supply. Fortunately, 3 state components permit the use of a single integrated circuit to accomplish this function as shown in figure 2. The level of current required for writing will be a function of the recording head, and will typically be around 5 to 15 mA. In my El Cheapo, the head winding resistance was sufficiently high that TTL voltage levels could be impressed directly across it and yield the proper level of current. Other heads, particularly those designed for digital use, may have much lower winding resistance, and feeding TTL voltages to such heads with no current limiting would be disastrous. An ohmmeter on the Rx10 or Rx100 scale, or the manufacturer's data sheet for the head, should be used to ascertain the value of external current limiting resistance required. One such digital head (Vicron P-3S7J3-B) has a DC resistance of 40 ohms, and requires 6 mA of write current. Assuming a TTL output voltage of 3.2 V, the required current limiting resistance should be 3.2/0.006 or 533 ohms. Since 40 ohms is accounted for in the winding itself, approximately 500 ohms of external resistance should be used. As shown in the schematic, in my design I split the current limiting resistance into two sections to maintain symmetry, but this was not seen to be really necessary. Note that the advantage of 3 state components in this application lies in the fact that during read operations the drivers can be placed in their high impedance state so as to have no effect on the input head circuitry, thereby obviating the need for any mechanical switching between read and write operations.

Reading the recorded data is slightly more complex since the signal levels coming from the head winding will be on the order of microvolts and since the data must be reconstructed as explained previously. Figure 2 shows the read circuits I recommend. The actual amount of amplification required in a system will be a function of the head employed and the tape speed. Digital heads with low inductance will require more



POWER WIRING TABLE

		Analog +5 V	GND	Digital +5 V
IC1	74125	—	7	14
IC2	7402	—	7	14
IC3	555	—	1	8,4
IC4	LM1458N	8	4	—
IC5	LM311N	8	4	—
IC6	LM311N	8	4	—
IC7	7474	—	7	14

Note 1: The 555, IC3, is a timer which is used to stretch the write enable signal, thus forcing the head to write steady data after the program has turned off output at the end of a write operation. This blanks out the tape during motor slow down.

Note 2: See the text for an explanation of the write current limiting resistances R.

Note 3: Test point 1 should be slightly under 2.5 V when the system power supply is +5 V.

Note 4: Pick R1 and R2 (nominally 100 k and 18 k here) so that the peak to peak amplitude of the signal at test point 4 is 2.0 V. There is no need to use a potentiometer if the physical mounting of these resistances allows substitution from your parts box.

Note 5: Test points 2 and 3 are (respectively) the upper and lower thresholds for the comparators. Adjustment of R3 will vary the width of the gap between the thresholds.

Note 6: There are two "+5 V" supplies in this circuit. The raw system supply as it comes to the circuit is referenced as the "digital +5 V" in this diagram; the isolated and filtered "analog +5 V" is used to supply the amplifiers and comparators.

Figure 2: Schematic of a Direct Digital Recording Interface. The output circuit takes NRZ data from the computer's 1 bit output port (assuming the write enable line is at zero) and drives the heads directly from two 3 state gates in a 74125 package. The input circuit is overdriven and should be ignored during output operations. For input, the write enable line is high, disabling the 3 state drivers, allowing the signal from the head to be processed by an amplifier section followed by a pair of edge detectors which reconstitute the data in a set-reset flip flop.

amplification since they will generate smaller voltages. The amplification should be set so as to provide a peak to peak signal of roughly 2 or 2.5 V at the inputs to the comparators (test point 4).

The two comparators provide two thresholds which are symmetrical with respect to VCC/2 (2.5 V). The thresholds are adjustable, but should always be symmetrical with respect to VCC/2, since the amplified tape signal is symmetrical with respect to VCC/2. Adjustment of the thresholds is not especially critical, and can be done without a scope if needed. A compromise is effected between the highest possible thresholds (maximum excursion of the tape signal) and the lowest possible thresholds (both equal to VCC/2). Adjustment is made empirically, keeping the thresholds as high as possible while allowing for dips in peak signal amplitude due to "dropouts." I found that thresholds of between 25% and 75% of the peak signal amplitude were usable and favored the 75% end so as to discriminate against possible noise or tape print through. This phenomenon occurs when undesired signals caused by adjacent layers of tape magnetize each other. Hence for a 2 V peak to peak signal with a 2.5 V centerline, the thresholds are nominally as follows:

Low: 2.5 – (2.0/2) * 0.75 = 1.75 V
High: 2.5 + (2.0/2) * 0.75 = 3.25 V

These values are suggested as starting points, not necessarily as the final operating levels.

Hence, whenever a positive going peak exceeds +3.25 V the 7474 will be set, and whenever a negative going peak goes below +1.75 V the 7474 will be reset. The output of the 7474 will then be a reconstruction of the original recorded data. The most obvious and probably simplest way to adjust the thresholds is by using a tape, prerecorded with repetitions of a fixed pattern such as an ASCII U, or hexadecimal AA or some other convenient value. With an oscilloscope connected to the output of the 7474, and synchronized to the start of each data word, the thresholds can be adjusted to give a stable representation of a single character across the scope screen. With the thresholds properly set, the individual bits should be stable throughout the entire length of the tape; if not, then either the thresholds are set wrong or the scope is not properly synchronized. In a normally operating system, purists may be able to observe slight jitter in the positions of the bit transitions, which is due to varying magnetization characteristics of the magnetic medium. This is normal, and should be only a fraction of a percent of the overall character time. The type of cassette may be important here, although not necessarily critical at lower densities of recording. Of five different types of cassettes tried, all worked except for a bargain basement cheapie whose dropouts were so severe as to render it useless even for its intended audio applications. Certification is not necessary; willingness to buy respectable brands is sufficient.

Emulation of a Paper Tape Facility

Users who intend to use a cassette recorder as a replacement for the paper tape functions of the ASR33 or similar Teletypes will have some extra mechanical functions to worry about. Problems are incurred when the tape is started and stopped, because of the time required for the motor to accelerate or decelerate. During this acceleration or deceleration time, data must not be present on the tape, since errors will occur unless some sophisticated speed tolerant technique is used. One solution to this problem is to incorporate leaders and trailers of blank (erased) tape during the write operation.

The use of leaders before and trailers after a string or block of data requires a delay of a fraction of a second before and after the passage of the data. It is therefore necessary that the tape output software must wait until the motor startup delay has passed before transferring any data. One way to accomplish this is to buffer the input data. The output routine could write to the buffer whenever and at whatever speed it wants to, and after the buffer is filled it is then transferred onto tape along with the necessary leaders and trailers. This requires more hardware in the form of memory for the buffer, and more software in the form of routines to handle transfers into and out of the buffer.

Another, simpler way to accommodate the necessary delays is by modifying the program which uses the tape IO to allow for the delays whenever it writes to tape. A valuable practice among software writers is the organization of the character input and output routines into a single subroutine for each, which is called by other software. In software designed for paper tape emulation it is a simple task to add the appropriate delays whenever the PUNCH-ON or PUNCH-OFF Teletype command codes are encountered. The software which is documented in this article presupposes that software which requires the IO will tolerate the appropriate time delays. There are also some simple additions to the hardware which will reduce the software overhead by incorporating the needed delays into the system. Motor coasting after power is removed is the longest time interval which must be accom-

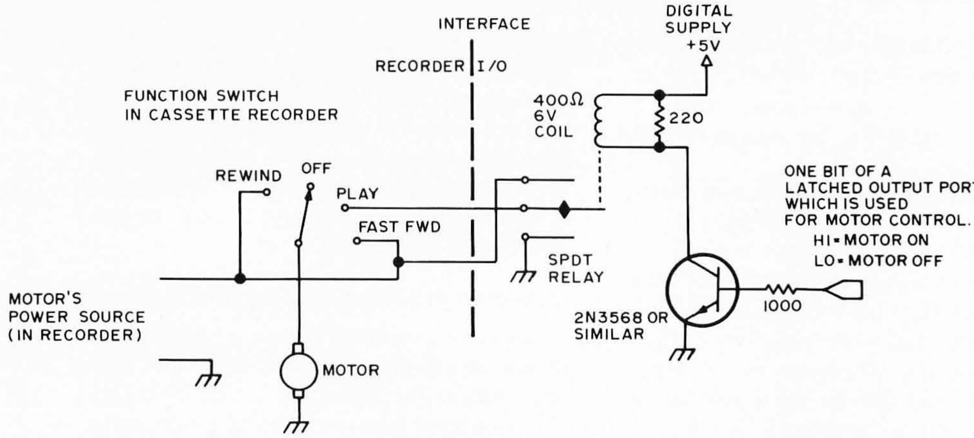


Figure 3: Motor Control Circuit. The relay is used to control the motor of the tape recorder, driven from an output bit of the computer. The relay is a single pole double throw variety which shorts out the motor if the motor is not on. This guarantees that the motor will generate current during slowdown, which is dissipated in the wiring of the short circuit, braking the motor electromagnetically. (This braking action of a DC motor operated as a generator is used as a key principle in the design of regenerative braking systems for electric railroads, street cars and electric cars.)

modated, and fortunately it is a simple matter to reduce this time significantly.

In the unmodified cassette recorder the motor is turned off by breaking the current path from its power supply and leaving it open circuited. If, after breaking the current path, the motor windings are short circuited, its coast will end much sooner. A simple circuit shown in figure 3 uses an SPDT relay contact to accomplish this with no disturbance to the original motor wiring on most cassette recorders. The rewind and fast forward circuits function as before; only the forward circuit is changed.

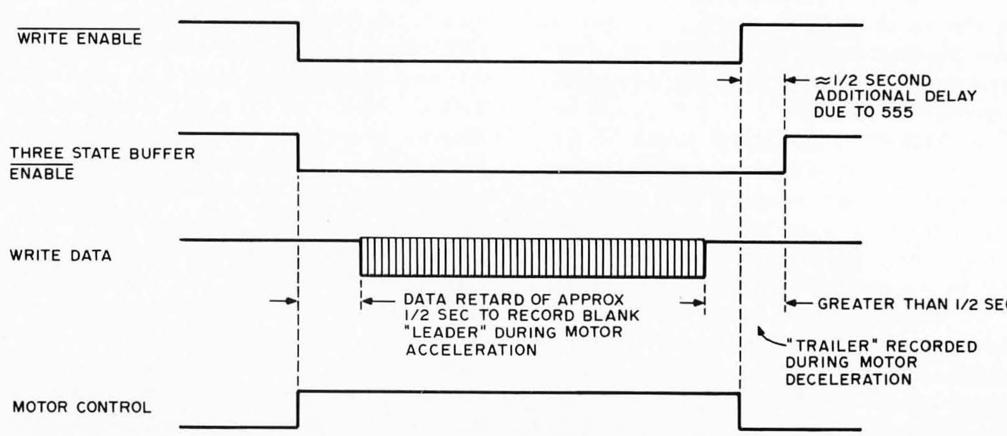
Since the motor coasting time can only be reduced, not eliminated, it may be desirable to use a oneshot in the hardware to keep the write enable line on following a write operation, until the motor has stopped. Figure 4 illustrates the timing characteristics desired. This guarantees that the tape which passes the head during motor coast will be erased by holding the outputs constant with no data transmitted.

The equivalent function at the beginning of the write operation is not necessary since the write enable will be on from the moment the motor is turned on and all during the time it is accelerating up to speed.

Software

Since the hardware is doing no more than writing or reading one bit at a time, the functions of serial to parallel and parallel to serial conversion must be assumed by software, as must the encoding or decoding of data, as well as timing of the individual bits. This would seem to cause considerable software overhead; but in my prototype all the above functions, plus those of motor control and checksum calculation and verification, were accomplished in approximately 230 bytes on a 6800. This number can easily be reduced, either by shifting some of the simpler functions such as bit timing to hardware or by eliminating some of the prototype's features such as paper tape

Figure 4: Block Timing. This diagram shows the timing of a block of data during a write operation. The logical OR function provided by IC2c causes the 555's delay to extend the actual 3 state buffer enable beyond the end of data by about 0.5 seconds. The software should provide a leader delay of approximately 0.5 seconds preceding the start of data to allow the motor to turn on and come up to speed. The motor control timing is also shown in relation to the other signals.



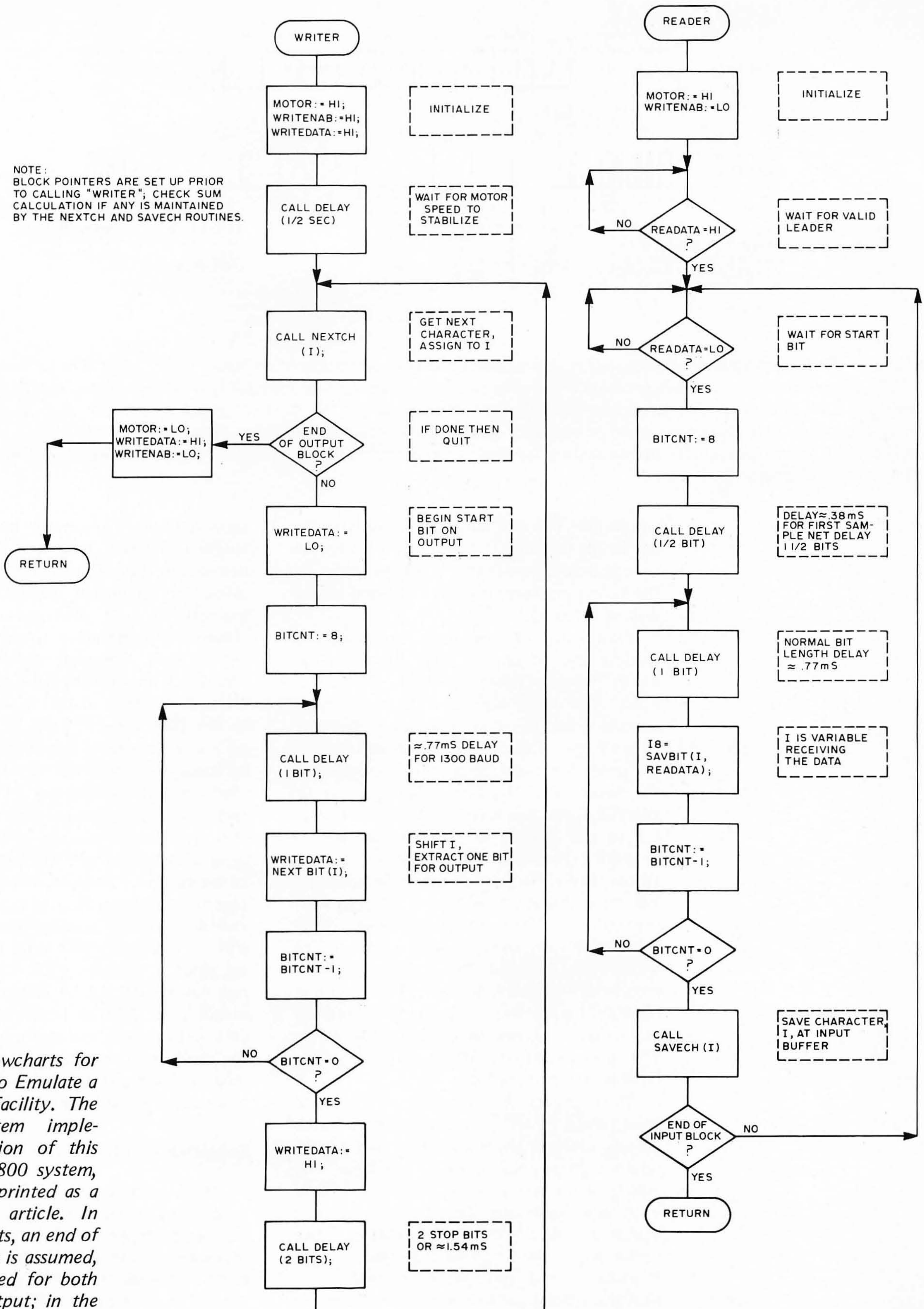


Figure 5: Flowcharts for IO Software to Emulate a Paper Tape Facility. The author's system implements a version of this logic for a 6800 system, which is not printed as a part of this article. In these flowcharts, an end of data condition is assumed, but not defined for both input and output; in the author's version, ASCII control characters were used to communicate this information.

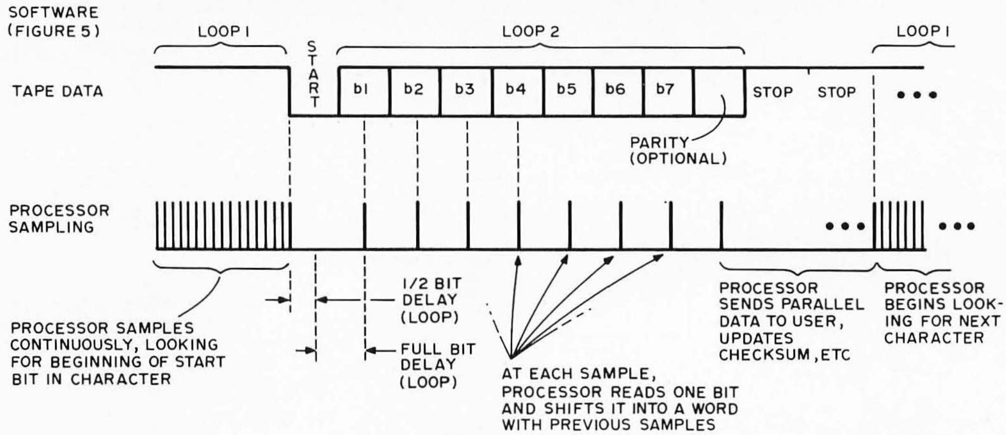


Figure 6: Timing of Input Operations. This timing diagram details operation of an input "read" algorithm for non return to zero (NRZ) data recorded in an asynchronous 8 bit data format containing one start bit and two stop bits, identical to one of the standard UART formats. The processor continuously samples during the start bit search of LOOP1, then it waits for 1.5 bit times and begins sampling once per bit period until all the data has been shifted into a register by LOOP2. Then it processes data and sends it to an input buffer before testing for end of input and going back for more sampling if needed. This input sequence repeats for each character.

emulation. The real advantage of this design lies in the fact that the hardware is so simple that it determines few of the capabilities of the system; instead, the user defines them by way of software.

Flowcharts of the basic functions for reading and writing data are shown in figure 5. The write function is fairly straightforward. The read algorithm is a bit more confusing and deserves explanation. In order to read a serial data word, two time intervals are used. Since the data will be sampled in the center of each bit, sampling must be delayed from the leading edge of the start bit to the middle of the start bit before beginning the sampling process on the bit string. Thereafter, samples will be spaced a full bit width apart, as shown in figure 6. In my version of the software, a single delay subroutine was used, and the amount of delay was changed by dividing a delay parameter (DPARAM) value by 2 with a right shift when the half bit width increment was needed, otherwise using its full value. The balance of the input software is relatively straightforward.

These algorithms are for simple NRZ (non return to zero) data, which was chosen for its ease of implementation and for its relative density as recorded on tape. The ASCII characters can be recorded directly onto tape, including their start stop bits in standard asynchronous format. Other methods of recording data onto tape, such as Bi-phase-L and Bi-phase-M, require more flux transitions per character than I cared to contend with. Readers who are interested in investigating or using a different coding scheme should refer to the bibliography. Since the amount of data which can be squeezed onto magnetic media per unit length is inversely proportional to the number of flux transitions per data bit, NRZ in asynchronous format seemed an acceptable method for my purposes since its synchronizing information is carried only once within each character, rather than within each bit. Using straight NRZ at 1300 baud (a bit width of 0.77 ms) with the tape moving at the standard 1 7/8 ips (4.5 cm/sec) results in a density of approximately 700 flux reversals per inch worst case. Commonly used commercial densities are 800 and 1600 frpi, but I encountered degradation above 700 frpi due to the use of the audio tape head which came with the cassette recorder; adjacent flux reversals tended to merge together and cause significant amplitude variations during reading. The value of 700 frpi has proven to be a valid design parameter since it provides good data rates yet is not easily affected by dirt or variations in media type. Other cassette interfaces require certified cassettes and scrupulous cleaning of the head; the one described here has worked reliably for months now, with no attention to cleanliness since initial alignment.

Suggestions for Improvement of Performance

The biggest advantage of this system is its relative independence from the associated hardware. Hence the user may simplify the software to the point that it is merely a bootstrap loader for larger programs, or can expand it, incorporate buffers for movement of data, use self clocking methods for data encoding, and ultimately configure a complete cassette operating system using the hardware described here. Still there are

points for improvement, if one is willing to spend a little money. A tape head designed for digital use can make a considerable improvement in performance in two ways: its narrower gap will permit recording at a higher density, and its lower impedance will permit movement of the tape at higher speeds before its inductance causes the recovered pulses to merge together. When using such a head, recall that its DC resistance will be much lower, and that it would be disastrous to feed unlimited write current to it directly from the 74125s. Current limiting resistors must be used. Consult the manufacturer's specifications for appropriate current levels.

Since serial/parallel conversion is accomplished in software, the processor will be required to execute fast enough to accurately provide timing for each bit, with an accumulated error small enough to accurately provide room for tape stretching, and wow and flutter of the cassette drive. Data from my prototype suggest that a data rate of at least 2400 baud should be possible with a 6800 processor operated at its maximum clock frequency of 1 MHz. With care it might be possible to increase this rate substantially.

It is hoped that this introduction of saturation recording techniques will provide experimenters with higher speed mass storage at rock bottom prices. For those concerned about compatibility, it should be noted that the hardware is so simple that it should be feasible to support almost anyone's recording format without changing the hardware in any way. Each user will be free to develop his or her own pet format, yet still be compatible with everyone else's by merely writing the appropriate software.■

BIBLIOGRAPHY

1. Marsh, Robert M, "Computer Bits," *Popular Electronics*, March 1976, page 88.
2. Javid, Baha, "New Techniques Squeeze More Data onto Magnetic Tape," *EDN*, June 5 1975, page 63.
3. Motorola Applications Note AN-711, "The Recovery of Recorded Digital Information in Drum, Disk, and Tape Systems."
4. Kim, SooNam, "An Inexpensive Audio Cassette Recorder Interface for uP's," *EDN*, March 5 1976, page 83.
5. Pestoriza, James J, "Tradeoffs Among Binary Codes in Magnetic Tape Cassettes," *Computer Design*, 1975.
6. Memodyne Corp, "Recording Binary Code on the Philips Cassette" (application note).

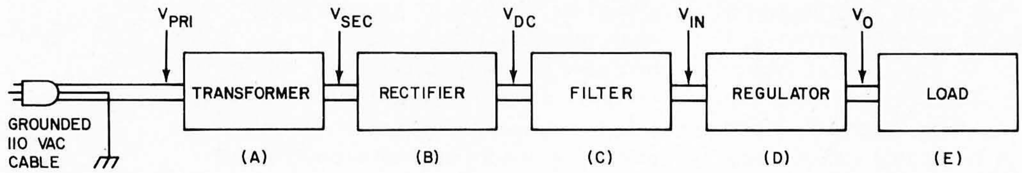


Figure 1: The Power Supply as a System. This is a block diagram identifying the conceptual divisions of a typical power supply system.

Watts Inside a Power Supply

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Ever spend an hour or so entering software in your system, when suddenly the air conditioner or furnace kicks in, leaving your all too volatile memory looking like garbage? Power supplies are very important components to a small computer system; and careful consideration, before building or buying, will help make your system more reliable.

The purpose of this article is to acquaint the reader with some basic principles of power supply operation. There are many types of power supplies, but for the application to personal computing systems, only the well regulated, low voltage type will be considered here. Also, the power input will be assumed to be the North American norm of a 115 VAC, 60 Hz wall outlet.

Before selecting a power supply, the voltage output and its regulation must be determined. This is usually set by the kind of circuit being supplied. For example, TTL logic requires +5 V at ±5% regulation in order to satisfy design specs. The major decision that must be made is the amount of current that the supply will need to deliver. Integrating additional supplies at a later time is somewhat difficult, and it is usually wiser (and cheaper in the long run) to select a supply that will meet anticipated needs as your system grows.

Table 1: Symbol definitions used in text, equations and schematics of this article.

Vpri	—	Voltage applied to transformer primary (120 V rms, 60 Hz).
Vsec	—	Voltage of the secondary winding (rms).
Vdc	—	Rectified DC voltage.
Cf	—	Filter capacitance.
Vin	—	Rectified and filtered voltage supplied to regulator.
Rz	—	Series zener resistor.
Vo	—	Regulated voltage supplied to load.
Io	—	Maximum current to be supplied by load.
I_f	—	Current rating of fuse.

The basic function of a power supply can be segregated into five components as shown in figure 1. These are stepping the line voltage to a lower more desirable value (A), changing the alternating current to a direct current (B), filtering the DC (C), making sure the voltage is held constant under adverse conditions (D), and distributing the current to the device to be driven, called the load (E). The symbols given to the voltages at each point are listed in table 1 to avoid confusion.

Converting the line voltage into a lower voltage is accomplished by using one of the most efficient electrical devices ever developed, the transformer. The power transformer is a chunk of laminated iron plates with a minimum of two wires wrapped around it. The ratio of the number turns around the core for each wire determines the AC voltage ratio of the transformer.

For power supplies, the winding that is connected to the power line is called the primary, and the winding that gives the rated voltage of the transformer is called the secondary. Transformers will often have multiple secondaries, giving many output voltages. Power transformers of this type are often called line transformers.

Selecting the proper transformer consists

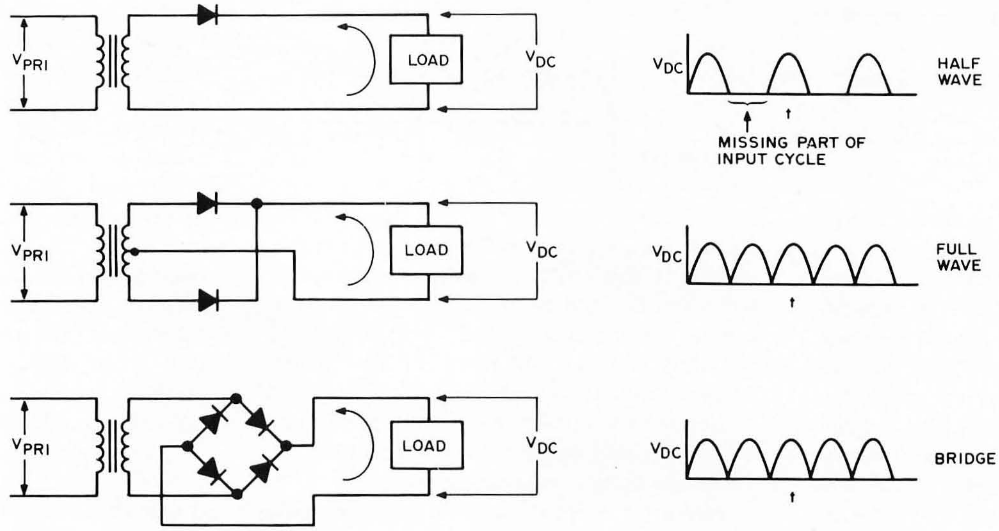
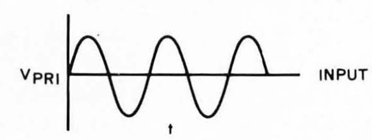


Figure 2: Common Rectification Schemes. The half wave rectifier gets its name from the fact that only half of the input cycle is utilized; the full wave rectifier uses the whole cycle, but requires a transformer with twice the voltage desired, and must have a centertap. The bridge rectifier is also a full wave rectifier, but adds some extra diodes as a trade off against the center tapped higher voltage transformer required by the simple full wave design.



of finding one with a voltage rating close to the desired voltage. The final value of this voltage depends on the type of rectification and regulation to be used. These considerations will be noted later.

While keeping cost in mind, you should also select one with at least as much current capacity as you expect to need. A lower voltage or current rating than will actually be used will cause the transformer to overheat and may short out the windings, possibly causing damage to the load.

A little caution should be exercised in looking at transformer specifications. If a secondary winding is center tapped, or has a lead connected to the middle of the winding, be sure you know whether the given voltage is for the full winding or for each side of the winding. Also, the voltages are usually rated in effective or rms ("root mean square") values, but may be given in peak values. To convert from rms to peak or peak to rms voltages, use equation 1 in table 2.

The next step is to convert the alternating current to a direct current, a process called rectification. This is normally done with diodes and in this application such diodes are referred to as rectifiers. The diode is a device that will only pass current in one direction and, in the common notation for diodes, current flows against the arrow.

There are three common approaches to rectification: the half wave, full wave, and bridge rectifiers. An example of each is shown in figure 2. The half wave rectifier conducts only when the AC is carrying current in the direction the diode will pass. The output waveform is shown; and since it only passes half the AC cycle, it is not very efficient. Filtering is also more difficult for this rectifier. As a result, half wave rectification is seldom used in a well regulated supply.

The full wave rectifier uses a transformer whose secondary winding is center tapped. With this type of transformer, the full secondary voltage rating must be twice the desired output. However, the whole cycle of the wave is used by only using two diodes with it.

Another type of rectifier which uses the entire input cycle is the bridge rectifier. It requires four diodes, but a center tapped transformer is not required. Bridge rectifiers are available in complete packages with four leads for easy implementation, and are probably the most widely used form.

Be sure to use a diode with greater

Table 2: A reference list of useful equations for power supply design.

Eq. 1	Vrms = Vpeak * 0.707 (Vpeak = Vrms * 1.414)
Eq. 2a	PIV > 4 * Vsec (for half or full wave rectifiers)
2b	PIV > 2 * Vsec (for bridge rectifiers)
Eq. 3a	Cf > (0.066 * Io)/Vin (for half wave rectifiers)
3b	Cf > (0.033 * Io)/Vin (for full or bridge rectifiers)
Eq. 4a	Rz = (Vin − Vo)/Io
4b	Pz = Io^2 * Rz
Eq. 5a	I_f = (Io * Vsec * 5)/Vpri (for slow blow fuse)
5b	I_f = (Io * Vsec * 10)/Vpri (for fast blow fuse)

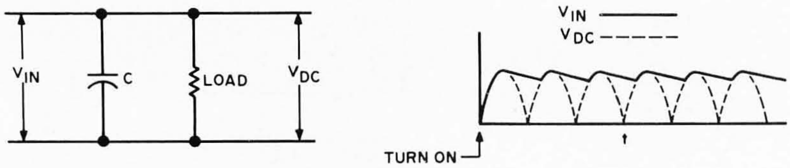


Figure 3: Using a Capacitor for Filtering. The capacitor charges up whenever a voltage is applied, and the load resistance tends to discharge the capacitor. The net result is a tendency for the voltage to remain approximately constant with ripple left over from the rectification.

current capacity than will be drawn from the supply. If this rating is exceeded, the diodes will overheat and be destroyed. This rating can be extended with heat sinks and fans, but it is cheaper and more reliable to use adequate diodes to begin with.

Besides the current rating, the maximum voltage applied in the opposite direction the diode conducts should not be exceeded. This is measured in peak volts, called the peak inverse voltage, or PIV. Determining the exact peak inverse voltage rating depends on the kind of load and filter being used. A safe "rule of thumb" to follow is to allow the PIV for the half and full wave rectifiers to be at least four times the secondary voltage and at least twice that for the bridge diodes: see equation 2a or 2b of table 2.

The next step in getting the voltage into a usable form is called filtering, and this smooths out the pulsating DC into a more constant voltage. There are many different methods for filtering, but for low voltage supplies the capacitor input type is best.

The effect of placing a capacitor across the rectifier is shown in figure 3. As the supply is turned on, the first pulse from the rectifier charges the capacitor. As the first pulse drops, the capacitor discharges until the next pulse charges it, and so on, giving the resultant waveform.

Specifying the correct filter capacitor involves two more ratings. The voltage rating should be greater than the peak voltage applied to it. The other rating is the capacitance, and to specify this we must look at an important factor in the supply, the ripple.

Ripple is the ratio of the AC still left on V_{in} to the average DC level of the filter output. Ripple may be expressed as a percentage or in decibels. The larger the capacitance, the longer it takes the capacitor to discharge and the smaller the ripple will be. The period of the ripple is the reciprocal of its frequency; for a 60 Hz line this is 1/120, or 8.33 ms. The capacitor should have a time constant of at least four times the ripple period. Using these constants, a formula for determining the capacitance is given in equation 3 of table 2. Remember, this is a minimum value, and the tolerance of the capacitor should be taken into account.

To conserve space or cost, several small capacitors may be added in parallel to reach the desired capacitance. Also, V_{in} will be closer to the peak value of V_{sec}, and this must be considered when selecting a transformer.

The equation for determining the capacitance was based upon 120 cycles per second and does little to filter out higher frequencies that may be on the line. Induced RF noise may be filtered out by adding a 0.1 μF capacitor across the supply.

Now that filtering is accomplished, we have a direct current with some ripple at any given voltage we specify. However, the voltage will only remain as desired if the load resistance and line voltage are constant. The line voltage is hardly constant and may vary from 90 to 130 V and can momentarily rise to 300 V in some instances of surges. In an application where the load resistance is constant, a simple voltage dropping resistor may be used to drop V_{in} down to the voltage the device needs.

However, this method wastes the current through the resistor, and does nothing to prevent V_{in} from varying with line voltage changes. Also, most digital applications have varying load resistances because of gate switching and memory operations and require a closely regulated supply, so something more sophisticated is needed.

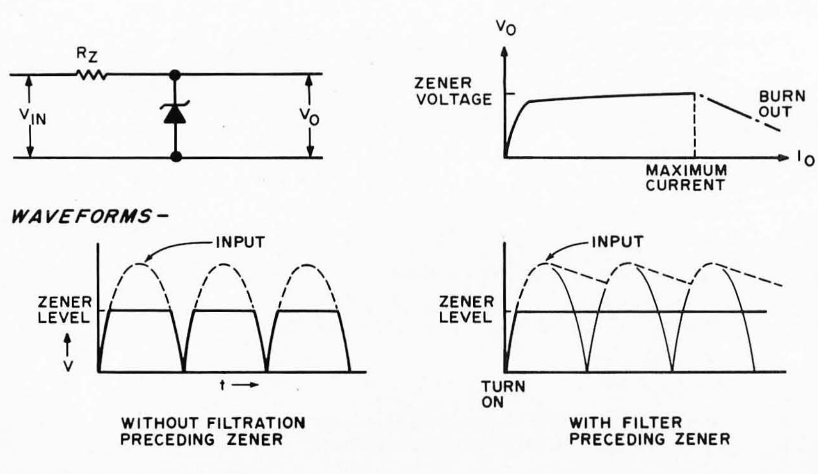
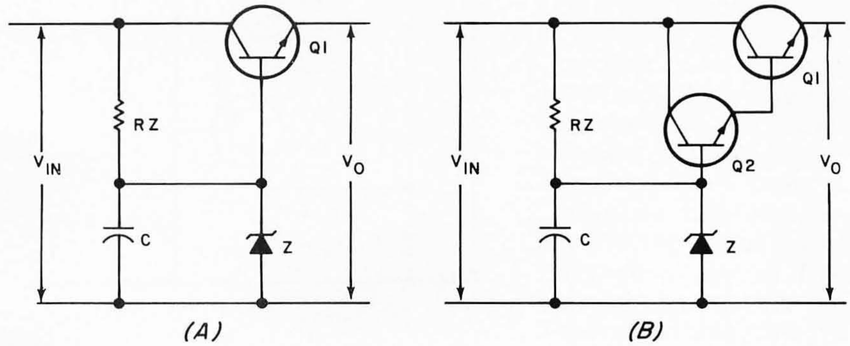


Figure 4: Zener Diode Regulation. Use of a zener diode is one of the simplest regulation methods. The zener is a low voltage semiconductor equivalent of what used to be a common item in vacuum tube equipment, the gas discharge regulator tube. When the voltage has increased to the zener level, the characteristic curve of the diode guarantees that it stops increasing. If used with unfiltered rectifier outputs, the choppy waveform shown is typical; if the average DC level with filtration is above the zener level, a steady supply results.

Figure 5: Using Series Current Pass Transistors. Because of the large amount of power burned up in the zener resistor, it is desirable to use the zener as a reference level rather than as the final active regulating element. This figure shows two similar ways of employing series "pass" transistors to regulate the output voltage with a zener reference. At (a) a single transistor is utilized; at (b) a "Darlington pair" is used to provide greater gain and thus a lower power level through the reference circuit of the zener diode and its resistor.



The simplest type of regulator is the zener (or reference, avalanche, breakdown, or regulator) diode. This diode is similar to the rectifier, except that it is reverse biased and is always used with a series resistor. The basic circuit is shown in figure 4, along with a characteristic operating curve. As the voltage across the diode reaches the zener voltage, the diode will conduct enough current to keep the voltage drop across the diode constant, keeping V_o held at the zener voltage. If the current becomes excessive, the diode will burn up; this is why a current limiting series resistor is always used.

Using a zener regulator consists of finding one with the proper zener voltage and power rating, and then calculating values for the series resistor. The zener diode should have a voltage rating equal to V_o and a current rating that exceeds I_o. The power rating is then calculated to be sure that it does not exceed the manufacturer's ratings, using $Pz = V_o * I_o$. The series resistor values are then calculated using equations 4a and 4b of table 2.

Note that V_{in} must be greater than V_o; actually $V_{in} = V_o + I_o * R_z$, and V_{in} should be measured at the lowest ripple voltage. Another feature of zener diodes is that they may be connected in series to increase the regulating voltage or to achieve a voltage not available in a single zener.

A quick survey of zeners shows that it is not practical to use this simple approach in high current supplies because the wasted current thorough R_z is inefficient and the generated heat becomes a problem. High current zeners are also expensive. A way to extend the current capacity of zeners is to use a series current pass transistor as shown in figure 5a.

Most of the current now being supplied passes through the power transistor with the voltage of its base being controlled by the zener. The 2N3055 is a typical type of power transistor for this purpose. R_z must now be chosen to carry the zener current and the base current. Zeners themselves can be a source of noise, and the capacitor (C = 50 μF, typical) is added to provide filtering across the zener.

This method will increase the output current, but more input current is wasted through R_z. A more efficient method is to use two power transistors in a Darlington configuration as in 5b. The base current of Q_2 can now be much smaller and reduces the amount of heat generated by R_z.

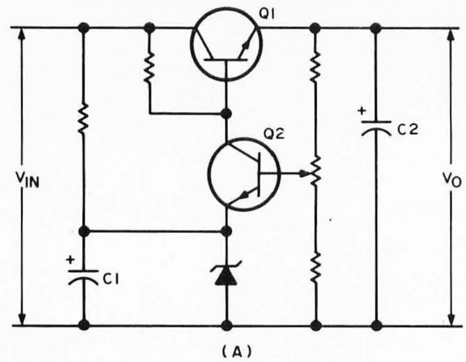
Using a zener in this way, with or without pass transistors, provides a fair regulation with few components and is suitable for some applications. However, it still does not guard against variations in the line voltage. A much better method would be to use a type of monitor to watch V_o and check for variations from the desired output. This is called a feedback, or closed loop regulator.

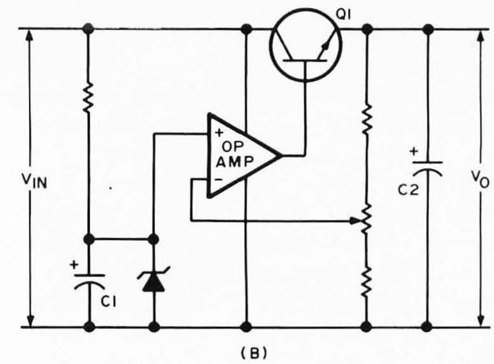
Figure 6a shows a simple closed loop regulator. Q_2 acts to bias Q_1 according to the condition of V_o and uses the zener voltage as a reference. If V_o should suddenly raise or drop, Q_2 will automatically compensate until V_o matches the zener voltage. Because of the slight voltage drop across the transistors, the output voltage will be slightly less than the reference voltage of the zener. The variable resistor is used to adjust the bias of Q_2 and therefore adjust the output to exactly the voltage desired. C_2 is necessary to help filter fast transients caused by sudden current changes from the load and also helps to keep Q_2 from oscillating.

In figure 6a Q_2 acts like an amplifier for V_o. The important part of this signal is actually the difference between V_o and the reference voltage. A differential type of amplifier used here would therefore increase the sensitivity of the monitor, and an integrated circuit op amp fits this application neatly. A simple circuit using the op amp is shown in figure 6b.

We can now say that we have a regulated power supply, but for how long? If a component in your system or supply should

Figure 6: A zener diode, or a zener with pass transistor, is an "open loop" regulator which pays no attention to the load. The circuit can be improved using feedback techniques to create a "closed loop" regulator which senses the output voltage and feeds it back to help control the pass transistor(s). At the left is a typical closed loop circuit employing transistors; at the right is a similar circuit using an operational amplifier as the feedback element.





fail, it may take the rest of your system with it!

One important approach to this problem is to limit the amount of current the supply will deliver. The most common current limiting device is the simple fuse. To protect all the components in the system, the fuse is usually added in series with either the secondary or primary transformer leads. Fuses are rated at the maximum amount of current they will pass, and a formula for determining the proper fuse size is given in equations 5a and 5b of table 2. A compensation factor is included for dealing with both fast and slow blow fuses. Since a lot of expensive damage can happen to your system in a very short time, fast blow fuses should be used. However, "experimental" supplies that may be subject to accidental shorts and other abuses should use a slow blowing fuse.

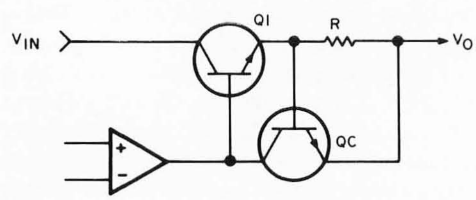


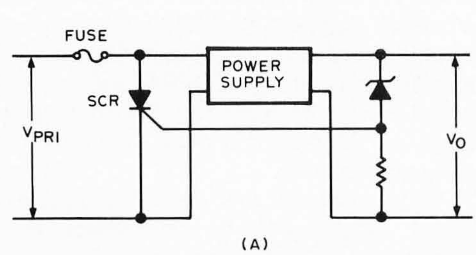
Figure 7: Current limiting is a very desirable protection method. Here is a typical current limiting configuration. The resistor R develops a voltage dependent upon the current to the load, and when the voltage goes too high, Q_C begins to cut off the regulator's action allowing the voltage to drop.

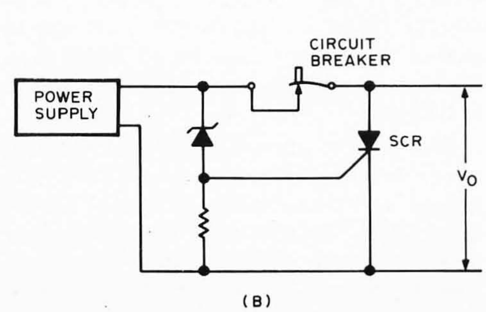
Fuses have one major drawback: They act so slowly that most semiconductor devices will blow before the fuse. Figure 7 shows a simple circuit that provides very fast current limiting. The resistor is chosen to produce a voltage drop as the current flows to the load. If the load current becomes too high, Q_C begins to turn on, reducing the base current of the pass transistor, thus limiting the current. The monitor amplifier will try to keep the voltage constant, but is not able to produce enough output current. After the current limit is reached, the supply will act like a constant current source.

Current limiting helps to protect the supply from shorts in your system, but the most important consideration is protecting your system from the supply. If the pass transistor short circuits, the entire unregulated output of the supply will deliver disaster to your integrated circuits. Protecting the load from a failing power supply consists of ensuring that the output voltage never rises above the value that the load can tolerate.

Solving this problem is another special diode, the silicon controlled rectifier (SCR). This diode conducts virtually no current until it is turned on, or "fired," at which time it conducts like a conventional diode. Figure 8a shows a simple type of overvoltage protection. The maximum V_O is set by the value of the zener diode. If V_O raises above

Figure 8: Attempts to protect against overvoltage and other ills of power supplies require careful thought. One of the most common methods is the "crowbar" circuit, so named because the SCR is used by brute force (as if it were a crowbar) to short out the power supply and blow the fuse or circuit breaker when the voltage exceeds a preset limit.





the zener voltage, the SCR will fire and short out the supply, causing the output to go to zero. After the supply has shorted for a brief moment, the fuse will blow. Instead of using a fuse, the SCR can be used to trigger a relay or circuit breaker as shown in figure 8b. This method of shorting the supply to prevent high voltages from reaching the load is often referred to as "crowbar" overvoltage protection.

Now at last we have a supply that provides ample current at the correct voltage with both current limiting and overvoltage protection. Getting the power to your printed circuit boards should be accomplished by using the shortest possible leads to prevent induced noise from reaching the integrated circuits. The ideal is wide, well filtered distribution, such as a bus and ground plane system. Using a capacitor (around 20 μF or so) across the supply leads on the printed circuit board will also help to filter the noise. (For more information about noise on printed circuit cards, see the article "Data Paths," page 32, in the February 1976 issue of BYTE.)

As anyone who has assembled one of the currently marketed system kits has seen, the regulator just described using discrete components can be fabricated on a single silicon chip. The integrated circuit regulator offers all the advantages of integrated circuits; ie: high performance, small size, easy implementation, and low cost. High current capacity is sacrificed because making high power monolithic integrated circuits has been difficult, but this is more than offset by the low cost of using many regulators.

There is a distinct advantage to using many small regulators instead of one large one. If one of the regulators fail, the rest of the system is isolated. Also, you only have to distribute unregulated voltage to each card and induced noise is much less of a problem, and adding additional regulators later on is no problem at all. Many kit manufacturers have adopted this philosophy in their designs. There are basically two kinds of integrated circuit regulators. The most common type is the fixed voltage regulator, exemplified by the LM340-XX or the 78XX series (where XX is a number indicating output voltage like 7805 for a five volt output). These are three terminal devices and can be wired in simply by placing bypass capacitors across the leads as shown in figure 9. These will supply up to one amp of current at any available voltage and have current limiting along with thermal shutdown if the heat becomes excessive.

The other type of integrated circuit regu-

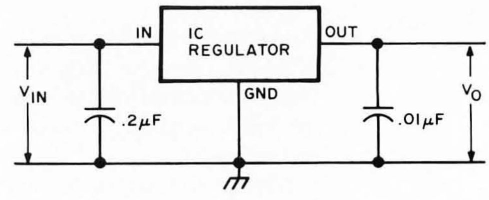


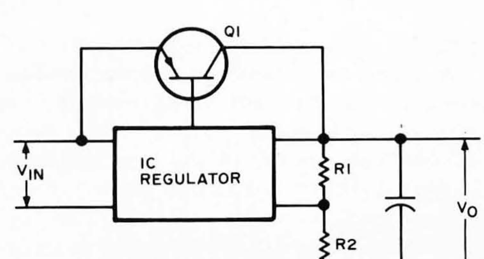
Figure 9: Integrated Circuit Fixed Voltage Regulators. Eventually, all computer activity may be reduced to a few chunks of silicon, highly refined and tattooed with intricate patterns. Evidence of this is the simplification in regulation provided by the typical integrated circuit linear regulator. Outside of the gross filtering capacitor always used on the raw DC supply, V_{in}, only two additional components are needed for the typical linear regulator. These components are small (typically ceramic) capacitors used to prevent radio frequency oscillations of the regulator. The only problem with contemporary IC regulators is that they tend to be limited in current capacity, hence the common practice of using many local regulators throughout a computer rather than one single regulator for the whole system.

lator is the variable voltage regulator that lets you specify the voltage output. A typical design is shown in figure 10. R_1 and R_2 set the voltage output and an additional pass transistor is shown to extend the current capacity. There are many variations on integrated circuit regulators, and none should really be considered without consulting the data sheets on them. An excellent guide is the *Voltage Regulator Handbook*, available at a National Semiconductor distributor.

An important parameter of the integrated circuit regulator is the dropout voltage. This is the minimum voltage drop that the integrated circuit can tolerate. For example, a 7805 (+5) regulator has a dropout voltage of 2 V. This means that 2+5, or 7 V, is the minimum voltage that should be supplied. Further inspection of the spec sheet shows that the maximum voltage that can be placed across this integrated circuit is 35 V. The higher the input voltage, the more power is wasted in the form of heat.

V_{in} at this point is determined by slightly less than the peak value of V_{sec}, and transformer voltage selection becomes important. If the value of V_{sec} is chosen so that V_{in} is exactly 7 V, the regulator will operate with minimal heat loss. However,

Figure 10: Some forms of linear integrated circuit regulator are designed for more complex operations, such as the kind used with a pass transistor for variable voltage supply outputs.



this makes the power supply very susceptible to power surges or even slight "brownouts." The transformer voltage selection should be carefully weighed between heat dissipation and reliability.

Saving the worst for last, the heat developed by regulators is an important consideration in both the discrete and integrated circuit versions. In the discrete design, the pass transistor must have some way of dissipating the power $[(V_{in} - V_o) * I_o]$ that is wasted. The same is true for the whole integrated circuit regulator. One popular method of using the integrated circuit variety is to use an on card heat sink, with or without fans to carry the heat away. Recommended heat sinks are usually available with the device specification. I fabricate my own on card heat sinks by using 1/16 inch strap aluminum from the local hardware store and a hacksaw for cutting the fins.

The reason that so much heat is developed in these kinds of regulators is that they are really nothing more than elaborate dropping resistors. Is there a better way? One possible answer is the switching regulator.

The switching regulator uses the pass transistor as a switch, regulating both the output voltage and the efficiency of the supply. A simple switching regulator is shown in figure 11. It is very similar to the series pass regulator except for the addition of a diode and an inductor. This inductor and R_1 and C and the error amplifier form

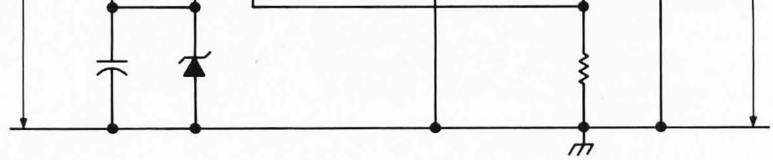


Figure 11: All of the linear regulators are really just fancy resistance elements which change their resistance to accommodate changing load conditions while keeping voltage constant. As a result they burn up power. The "switching regulator," such as that shown by this design idea, is an alternative which does not waste power in the pass transistor. It uses a variable duty cycle charging system for the output capacitor with feedback. In this conception, the pass transistor is always saturated "on" or "off" and never stays very long in the power consuming linear region of its operation. Thus the power wasted in the pass transistor is much smaller.

an oscillator that continually turns Q on and off. When Q is turned on, the voltage flows freely through the transistor and the power lost is small. When Q is turned off, there is of course no power lost. The output then forms a series of pulses that is filtered by the inductor. The diode is used to ground out the back emf of the inductor.

Regulation is maintained by varying the percentage of the cycle that the transistor is turned on. If the load requires more current, the time the transistor is turned on is increased. This is done by feeding the output back through the monitor amplifier to keep the voltage constant. Calculating the frequency of the oscillations is quite complex, and involves a trade-off between large expensive inductors and capacitors at low frequencies and expensive high speed switching transistors at high frequencies.

Switching regulators have their own disadvantages, however. It is hard to enjoy high efficiency at the lower voltages, like 5 V. Ripple is usually worse coming from a switching supply than a linear supply. An increased number of parts means some sacrifice in reliability. The frequencies (usually between 10 and 100 kHz) cause radio frequency radiation to the extent that shielding requirements are currently under investigation by the FCC. For the "average" hobbyist, linear regulation with careful consideration to heat dissipation is a much simpler approach.

What lies in the future? At the time of this writing, a three terminal 1.5 A regulator that is fixed *or* variable with few external components will soon be out. TI is reported to be working on an integrated circuit switching regulator. A variable zener reference integrated circuit and an overvoltage crowbar integrated circuit are in the works, all of which look as if they will be in the hobbyist's price range.

Although I have tried to give an example of each of the most common power supply designs, I have barely scratched the surface. However, for the novice or the software inclined, simple regulated power supply projects can be a lot of fun and give good introductory experience in reading component specs and packaging techniques. Integrated circuit regulator data sheets will often have excellent application circuits for building a fixed or variable supply. Then, if you should transcend the state of a simple kit builder and begin experimenting with components and measuring the ripple and percent regulation and operating temperature, then you will have arrived at a kind of power supply scientist, and — well, more power to you!■



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Pick Up BASIC by PROM Bootstraps

Jim Kreitner
RCA
6410 Kenilworth Av
Riverdale MD 20840

Most Altair owners tire of handloading the bootstrap loader for BASIC in a very short time, even though it is only 20 bytes. Here is a simple and very effective design for a 32 byte PROM board that holds the bootstraps for Altair Extended, 8 K, or 4 K BASIC (Version 3.2). The normal bootstrap sequence for the Altair BASIC programs is a two stage process which is initiated by the short programs which are usually toggled into the machine but are found in PROM in this version of the scheme. The first stage of the process is what is taken care of by the bootstrap PROM programming: The first block on the load tape is a longer bootstrap program which has a more elaborate loading facility. In principle, the longer bootstrap could have been used by MITS; but in practice, its length (over 150 bytes) makes hand toggle switch entry impractical.

The output of the regulator, and ground connections, should be wired as follows:

		+5 V	GND
IC1	8223	16	8
IC2	74L30	14	7
IC3	74L20	14	7
IC4	74L04	14	7
IC5	74L04	14	7

Table 1: Power Wiring List for Figure 1.

Split Octal Address	Octal Code	Label	Op	Operands	Commentary
300/000	046 057	EXTBASIC	MVI	H,057	Point H to extended BASIC load address;
300/002	303 014 300		JMP	BOOTS	Go to bootstrap routine;
300/005	046 037	BASIC8K	MVI	H,037	Point H to 8 K BASIC load address;
300/007	303 014 300		JMP	BOOTS	Go to bootstrap routine;
300/012	046 017	BASIC4K	MVI	H,017	Point H to 4 K BASIC load address;
300/014	056 256	BOOTS	MVI	L,256	Initialize low order load address;
300/016	061 035 300	JKLUGE	LXI	SP,KLUGE	Initialize stack pointer;
300/021	333 006		IN	ACRSTATUS	Read the SIO status flags;
300/023	017		RRC		Test low order bit in carry flag;
300/024	330		RC		Crude trick jumps to JKLUGE if not ready;
300/025	333 007		IN	ACRDATA	Read the SIO data value;
300/027	275		CMP	L	Is A = L [test null condition];
300/030	310		RZ		Tricky jump to JKLUGE if not null;
300/031	055		DCR	L	L := L – 1 [point to next byte];
300/032	167		MOV	M,A	@HL := A [store byte in memory];
300/033	300		RNZ		if nonzero, take trick jump to JKLUGE;
300/034	351		PCHL		go to tape bootstrap routine;
300/035	016 300	KLUGE	DA	JKLUGE	define address constant for trick jumps via return mechanism and ROM stack;

Listing 1: PROM Bootstrap Loader, listed as assembled for the Altair SIO board. The origin of the program is shown as location 300/000 (split octal addressing format). A version for a second PROM, starting at location 314/000, can be blown from the same assembly for use with the ACR interface, as described in the text. To derive the second version, simply substitute the octal value 314 in place of 300 in the shaded boxes shown in the listing.

Operation

The most general form of the bootstrap is shown in listing 1, suitable for either SIO or ACR use. The desired bootstrap is selected by examining the proper address, setting switch A14 down, and when the tape leader byte begins, the Altair is switched to the RUN mode. The PROM addressing is selected so that a minimum of switch changing is necessary – the schematic is for an Altair which uses a 2SIO board for the interface to the system's terminal. Since Altair BASIC requires that sense switch A15 is raised when loading BASIC from an Altair ACR cassette tape interface, and that A11 is raised for a 2SIO terminal, and A10 is raised for one stop bit, all that is necessary after power up and reset is to examine split octal location 314/0XX (where XX indicates the version of BASIC being used) and to set A14 down. The tape is then ready to load. If you are using an SIO interface for your terminal, then A11 and A10 should be inverted before they go to the 74L30. The address of the bootstrap loader will then be split octal 300/000 instead of 314/000. If you use only one version of BASIC the bootstrap can be rewritten with a tape leader detector preceeding the bootstrap, as shown in listing 2. This allows you to run the Altair without waiting for the leader byte to appear. The leader detector loops until the leader byte is received, and then jumps to the bootstrap loader proper.

Circuit Description

The circuit of figure 1 uses only six integrated circuits including the voltage regulator, and can easily be fabricated with a prototype board with either point to point wiring, Vector "Slit 'N Wrap" or standard wirewrap techniques. The 8223 PROM is

obtainable from many sources, and circuits to program the 8223 have appeared in previous issues of BYTE. Alternately, an 82S23 can be ordered and programmed by many of the larger electronics distributors for a greater price. *[For example, we at BYTE have purchased 82S23s burned from mark-sense cards by Hamilton Avnet.]* The numbers shown on the schematic are the Altair bus edge connector fingers.

Circuit Limitations

Because the circuit is designed for a minimum amount of switch flipping, it limits the memory to 48 K maximum if addressed at split octal 300/000 and slightly greater if addressed at 314/000. If you use more memory than this, you will have to change the circuit somewhat to obtain a higher address, avoiding conflicts on the bus, and change a few address bytes in the program. It will then be slightly less convenient to use; however, it will remain a vast improvement over the "power up, switch flipping blues."■

Split Octal Address	Octal Code	Label	Op	Operand	Commentary
300/000	333 007	BOOTER	INP	ACRDATA	read potential leader byte;
300/002	376 256		CPI	256	is it the leader byte?
300/004	302 000 300		JNZ	BOOTER	if not then continue looking;
300/007	041 256 XXX		LXI	H,START	HL := [starting address value] ;
300/012	061 031 300	JKLUGE	LXI	SP,KLUGE	initialize stack pointer for kluge jumps;
300/015	333 006		INP	ACRSTATUS	read status;
300/017	017		RAR		test low order bit in carry flag;
300/020	330		RC		if carry then take kluge jump to JKLUGE;
300/021	333 007		INP	ACRDATA	A := data [read input byte] ;
300/023	275		CMP	L	is A = L [test null condition] ;
300/024	310		RZ		if null then take kluge jump to JKLUGE;
300/025	055		DCR	L	L := L − 1 [point to next byte] ;
300/026	167		MOV	M,A	@HL := A [store byte in memory] ;
300/027	300		RNZ		if not null, then take kluge jump;
300/030	351		PCHL		go to tape bootstrap routine;
300/031	012 300		DA		define address constant for trick jumps via return mechanism and ROM stack;

Note: The value XXX at location 300/011 should be replaced by 057 for Extended BASIC, 037 for 8 K BASIC, and 017 for 4 K BASIC.

Listing 2: PROM Bootstrap Loader with Leader Detection, customized for a particular version of BASIC and shown in the form needed for the Altair SIO board. The origin of the program is shown as location 300/000 (split octal addressing format). A version for a second PROM, starting at location 314/000, can be blown from the same assembly for use with the ACR interface as described in the text. To derive this second version, simply substitute the octal value 314 in place of 300 in the shaded boxes shown in the listing. This version also requires substitution of a specific load address constant for extended BASIC (octal 057), 8 K basic (octal 037) or 4 K basic (octal 017) at location 300/011.

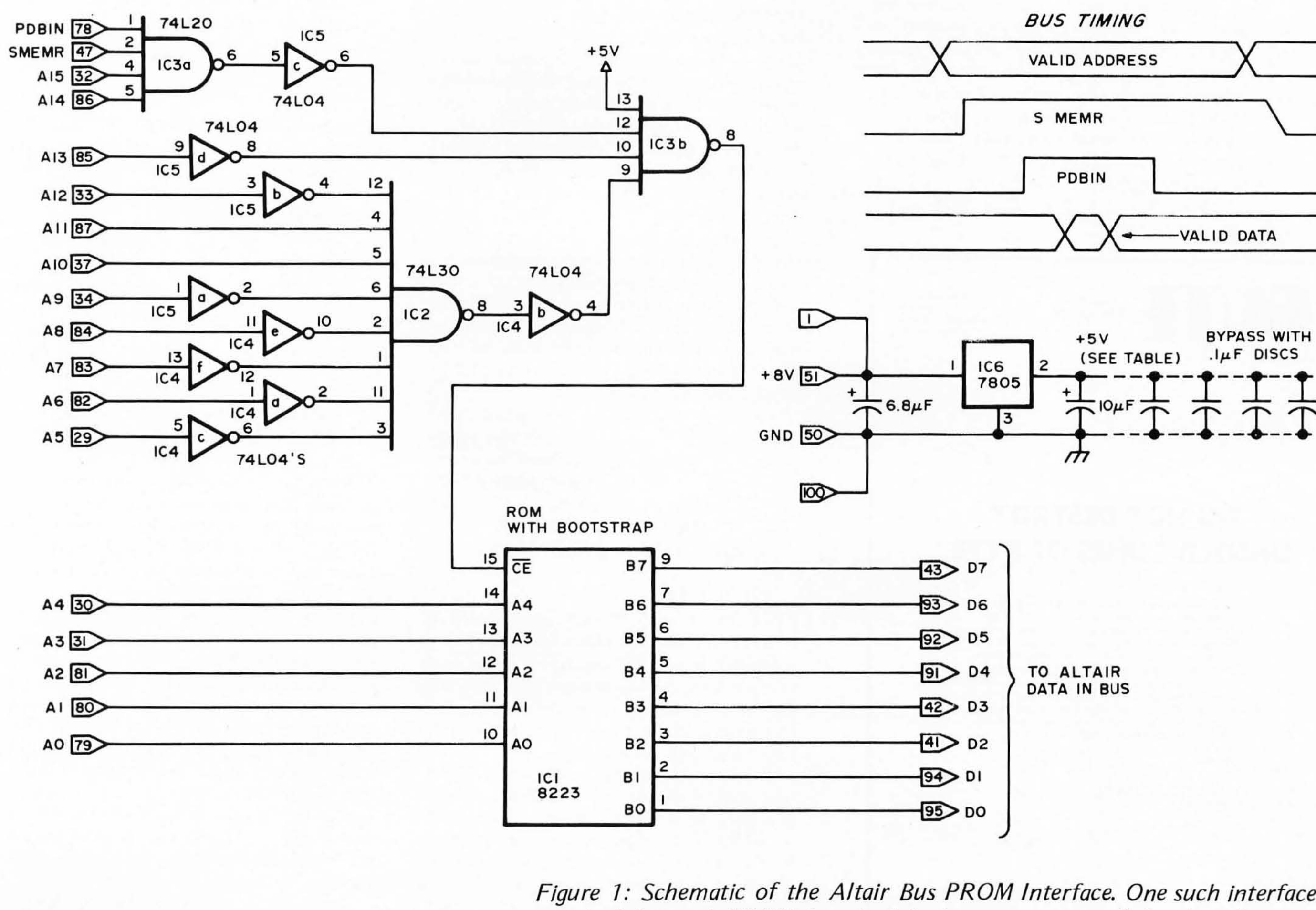


Figure 1: Schematic of the Altair Bus PROM Interface. One such interface is required for each PROM in principle; however, some of the decoding in the gates and inverters can be shared between two or more PROMs at different addresses.

Continued from page 16

lished works), and now in January, the author will have a federal copyright the very instant his work is put to paper. (Now it has to be "published" with copyright notice to get the federal protection.) This will have deep impact on program proprietors who think they can protect by trade secret the software they offer for sales.

Calvin N Mooers
Rockford Research Inc
140½ Mount Auburn St
Cambridge MA 02138

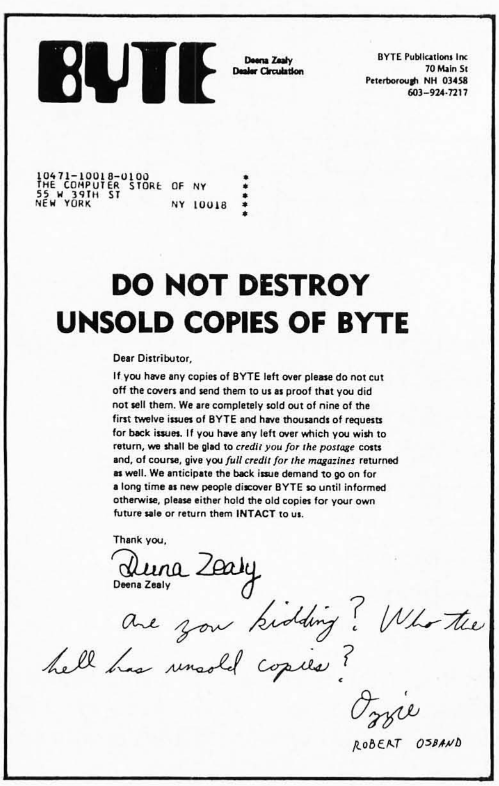
IN DEFENSE OF THE RIGHT TO PUN

Enclosed is my renewal for another year of BYTE. I was very reluctant to renew my subscription for one particular reason: The constant punning in the editorial and text material drives me crazy. It may seem like a petty complaint, but the puns and computer analogies completely spoil my enjoyment of an otherwise fine magazine. I may be the only reader that feels this way, but if the punning continues at its current level, I probably won't renew my subscription next year.

Richard Kramer

You should hear the complaints from the people around the office; at least the puns in BYTE, such as they are, are limited in context and subject matter. However, my observations on the matter of peoples' reactions to puns are that the more they complain the more they really want 'em. Any comments from other loyal defenders of a sophont's right to pun?... CH

Deborah Luhrs says, "Give that man a pun on the back."



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Ozzie
ROBERT OSBAND

KUDOS

I'm happy to send along my check for renewal. I look forward to each issue which seems better than the last. Please keep the 6800 articles coming. You've already saved me my renewal check. Again, well done and keep it up.

Bill Bennett K3TNM

Thanks.

CIE ENTHUSIASM

I was fired with enthusiasm by the idea of a Community Information Exchange [*October 1976 BYTE, page 90*]; please publish letters or articles which would aid such a project. More immediately, what can I do to help initiate such a net? I have written to Mr Wilber and Mr Fylstra to ask the same question but I believe your magazine could perform a valuable service by acting as a clearing house of ideas on this project.

Despite my enthusiasm for the idea of a CIE, I feel that Messrs Wilber and Fylstra were unduly hard on computer professionals. I'm not one, but I read some of the literature and my impression is that, far from "have(ing) protected their privileged position by keeping their knowledge to themselves," computer professionals reveal many more "secrets" in the various journals than do most professional groups, especially about software and software theory. Useful and efficient programs for almost any application can be written using the often quite specific articles and books on programming which literally abound. Even compilers are within the scope of the knowledgable amateur with books such as *Compiler Design Theory* (Lewis et al) which contains a very specific receipe for a simple BASIC compiler.

It is true that people who earn a living writing programs have shown a reluctance to donate their efforts to hobbyists and some have even been intemperate in their refusal, but this is scarcely surprising; in my experience they *are* willing to share their knowledge and in the long run that is all that a dedicated hobbyist needs.

E N Svendsen
Apt 1801
11200 Lockwood
Silver Spring MD 20910

HAM, CB CALL SIGN COORDINATION BY COMPUTER

Well, at last I got my subscription copy of BYTE. I really enjoy the articles, but a lot of it is over my head. It seems that quite a few computer people are also hams. I was first licensed back in 1955 and currently hold the call WA6TLJ. But there is no time for hamming until I get my new 8800b kit put together and up and running.

I have an idea about a computer application that may help out the Citizen Band operators. How about a computer generated list of modified nouns that would be issued by the FCC in place of the awkward present system of letters and numbers?

The whole idea of using letters and numbers to identify a voice transmission is out of date. Back in the 30s when most communication was done in Morse code the use of meaningless alphanumerics was quite practical. It was quicker.

However, numbers and letters are hard to use in plain language. To identify the letter "B" one has to use a phonetic like "Bravo." "Charlie" for "C." A waste of time.

Just as a programmer finds COBOL easier to use than a mnemonic assembler, so the average person would prefer to use a name instead of a number or letter combination to identify almost anything. Likewise CBers prefer the use of an adjective and a noun to identify one another.

I would suggest the following as modified noun call sign for stations using only voice transmission:

K (two-digit number) (adjective) (noun).

Example: K27 DANCING PLUM.

If there are 900 useable adjectives, and if we can find 1,400 acceptable nouns, then there would be enough call signs for all the people who want a personal radio and it would not be so difficult to identify one another.

Now we need a computer program to select a good list of adjectives and nouns and to spot any bad combinations.

John B. Palmer
POB 27462
Tucson AZ 85726

Now, all you have to do is get this same message through to the appropriate people at the FCC and push like crazy.

HELP!!!

I have bought a Raytheon terminal DIDS-400, model No. 402-2A-M11. Unfortunately it doesn't quite work. I am having some difficulty in finding a schematic. Could you please help me?

William R Hill Jr
214N 600E #3
Provo UT 84601

Readers with information to help Mr Hill, kindly write him.

WHAT ARE SR-52 INTERFACE DEFINITIONS?

Recently, I have become interested in personal computers and I am planning on having my own sometime in the near future (within 6 months or so). My problem is this: I also have at this time an SR-52. I would like to have some information . . . I really can't see forking out the cash for a TI printer if I am going to be getting a printer for a computer. What I would like to know: Is there anyone who could help me out on interface requirements? Has anyone done this type of thing yet? I saw the article on adding a math function unit in BYTE No. 13 which is a step in the direction I want to go, but, doesn't quite meet the idea I have. I would like for my computer to be able to operate my SR-52, and my SR-52 to operate my computer, providing hard copy both ways, or, on demand from either.

Any ideas you have or could get for me would certainly be appreciated. Cost is the biggest factor so far. As a matter of fact, *any* information on the SR-52's data contacts

would be helpful as then I might be able to design my own interface.

Ralph V Getsla MMI(SS)
NPS Staff
Mare Island Naval Shipyard
Vallejo CA 94592

Yes indeed, it should be possible to make an interface to the SR-52 plug. There are several ways this might happen: One is the way pioneered by Richard Nelson in his HP-65 users group newsletter with the HP-65, namely the owner doing research on what the components and design elements of a calculator are, then building interfaces. A second way is for someone at TI to send us a note on the interface definition and constraints for driving outputs, a note which might be published in BYTE as an article. The fact that it is possible is demonstrated by the existence of a general aviation navigation unit which is manufactured by Bendix, and which can optionally be programmed by an SR-52 when it is plugged into the calculator's printer socket.

AMATEUR RADIO NETWORKING INTEREST

I am interested in the current relationship between computer and radio amateurs. I have a BS in computer science (received a couple of months ago) as well as an amateur license. I have discussed some possibilities with Lee, WA9FGK, and we would like to get in contact with other hams and/or computer hobbyists with a similar interest. We would appreciate it greatly if you could communicate this to interested people.

Richard Rosenbaum WA2AOI
61-04 Little Neck Pkwy
Little Neck NY 11362

DOUBTING LIBRARIANS

I recently requested that our company subscribe to BYTE magazine for the company library. I filled out all of the necessary forms and sent them to the librarian. A few days later, I got a call from the librarian asking me a few questions about the magazine. The conversation went something like this:

"In this magazine, are there many advertisements?"
". . . A few."
"Are there many articles?"
". . . Quite a bit."
"Are there many black and white pictures?"
". . . The pictures are mostly black and white."
"They do have some colored pictures?"
". . . Yes."
"In this 'BYTE' magazine, do they have a centerfold?"

With some explaining in between subdued laughter, I finally got approval and today I got the company's copy of BYTE magazine with no centerfold.

Paul W Schmitt
Mine Safety Appliances Co
100 N Braddock Av
Pittsburgh PA 15208

REGARDING BAR CODES

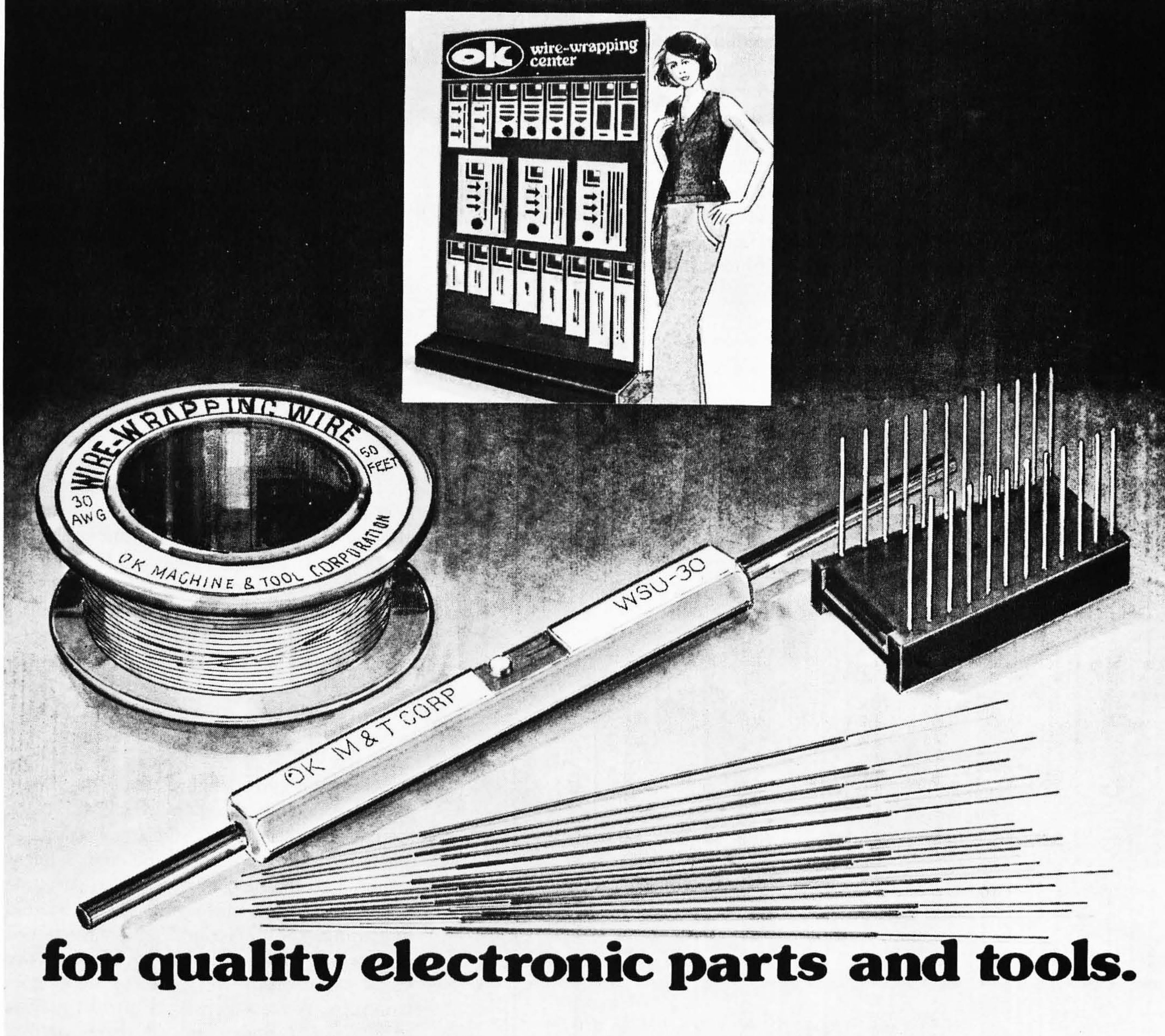
Henry G Baker Jr
MIT Laboratory for Computer Science
545 Technology Sq
Cambridge MA 02139

Next month, we'll print the decoded text of the letter Henry sent, which arrived as this month's issue went to press. The format of this letter is ratio encoding, format 2 of the three formats presented in November [page 12]. No synchronization or parity characters are used in this bar code text, which is the first paragraph of Henry's letter. This letter was produced by the MIT Artificial Intelligence Laboratory Xerographic Printer.

■

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Black Friday

Robert Baker
15 Windsor Dr
Atco NJ 08004

This computer game provides a realistic simulation of the actual stock market rather than a completely randomized happening of events. The program was written in BASIC for a DEC PDP-10 system so you may have to modify it slightly for your particular system. The game is programmed to allow one to four players with an option to play a game lasting from 3 to 10 years (rounds).

The first section of the program contains all the data to simulate the stock market, the names and abbreviations for the stocks, and the dividends paid by each stock. When the program is first started the player may ask for instructions if he is not familiar with the game. Then a table showing available stock names, abbreviations, and dividends is printed. This table is always printed for reference whether or not instructions are requested by the player.

In the program, stock names are stored in the vector S$, stock abbreviations in the vector V$, and yearly dividends are in vectors I$ and Y$. Matrix M is used to record each player's holdings, cash on hand, and dividends or interest for each year (round).

The market changes for each year are determined by first selecting at random one of the 36 market vectors of matrix A. Each of these vectors can only be selected once during a game. Bit 12 is set to a one when that vector is used. Bit one of each data vector indicates whether the year (round) will be a bull (1) or bear (0) market. For a bull market, a vector is selected from matrix U; and for a bear market, a vector is selected from matrix E. This randomly selected price change vector is added to the market vector and is stored in vector T to record the price change for that year for further reference. The price changes are also added to vector F which keeps track of the current price of each stock.

After the price changes are determined and recorded, the program checks for stock splits or bankruptcies. Any stock valued at $150 or more splits and the new value is rounded to the next highest dollar. Anytime a stock splits, a message will be printed indicating the split and all players will receive the extra number of shares. Any stock that drops in value to zero goes bankrupt. A message will inform all players of the bankruptcies and all shares of that stock will be surrendered. The value of that stock is then re-established at $100. When all necessary housekeeping is finished, the program will give each player dividends or

```
00010    REM       AUTHOR: ROBERT W. BAKER
00020
00030    REM       THIS GAME IS WRITTEN TO PROVIDE A REALISTIC MODEL OF
00040    REM       THE ACTUAL STOCK MARKET RATHER THAN A COMPLETELY RANDOMIZED
00050    REM       HAPPENING OF EVENTS.
00060
00070
00080
00090    RANDOMIZE
00100    DIM       A(36,12),U(11,9),E(11,9),I(10),T(10),S$(10),F(9),M(4,12),V$(10),Y$(10)
00110    MAT READ  A(36,12),U(11,9),E(11,9),I(10),S$(10),V$(10),Y$(10)
00120
00130
00140    REM       DATA TO SIMULATE REAL LIFE STOCK MARKET
00150
00160    DATA      1,0,0,0,0,0,0,0,0,5,0,0
00170    DATA      0,0,0,0,0,0,-25,0,0,0,0,0
00180    DATA      1,0,0,0,0,0,0,15,0,0,0,0
00190    DATA      0,0,0,0,-5,0,0,0,0,0,0,0
00200    DATA      1,0,0,0,0,0,0,0,0,5,0,0
00210    DATA      0,0,0,0,0,0,5,0,0,0,0,0
00220    DATA      1,0,0,0,0,0,10,0,0,0,0,0
00230    DATA      0,0,10,0,0,0,0,0,0,0,0,0
00240    DATA      1,0,0,0,0,0,15,0,0,0,0,0
00250    DATA      0,0,-5,0,0,0,0,0,0,0,0,0
00260    DATA      1,8,5,5,0,0,0,7,0,0,0,0
00270    DATA      0,0,0,0,0,0,0,0,-25,0,0,0
00280    DATA      1,0,0,0,0,0,0,0,10,0,0,0
00290    DATA      0,0,-10,0,0,0,0,0,0,0,0,0
00300    DATA      1,0,5,0,0,0,0,0,0,0,0,0
00310    DATA      0,10,0,0,0,0,0,0,0,0,1,0
00320    DATA      1,0,0,0,0,17,0,0,0,0,0,0
00330    DATA      0,0,0,0,0,-15,0,0,0,0,0,0
00340    DATA      1,0,0,0,0,0,0,0,10,0,0,0
00350    DATA      0,0,0,0,0,0,0,-15,0,0,0,0
00360    DATA      1,0,0,0,0,0,0,10,0,0,0,0
00370    DATA      0,0,0,0,0,0,0,-15,0,0,0,0
00380    DATA      1,0,0,-8,0,8,0,0,5,0,0,0,
00390    DATA      0,-10,0,0,0,0,0,0,0,0,0,0
00400    DATA      1,8,0,0,0,0,0,0,0,0,0,0
00410    DATA      0,0,0,0,0,0,0,-5,0,0,0,0
00420    DATA      1,0,0,3,0,0,0,0,0,4,0,0
00430    DATA      0,-8,0,0,0,0,0,0,0,0,0,0
00440    DATA      1,0,0,0,5,0,0,0,0,0,0,0
00450    DATA      0,0,0,0,0,-10,0,0,0,0,0,0
00460    DATA      1,0,0,0,0,0,0,10,0,0,0,0
00470    DATA      0,-8,-5,0,0,0,0,0-7,0,0,0,0
00480    DATA      1,10,0,0,0,0,0,0,0,0,0,0
00490    DATA      0,0,0,0,0,0,0,0,0,-14,0,0
00500    DATA      1,-10,0,0,0,0,0,0,0,0,0,0
00510    DATA      0,0,0,0,0,0,-5,0,0,0,0,0
00520    DATA      -2,-10,-7,-9,-2,-9,-7,-16,-4
00530    DATA      26,16,25,8,-14,21,14,-4,17
```

interest on all stocks that yield interest or dividends and are valued at $50 or more.

For each year a table will be printed indicating the current market price of each stock, the change since last year, the number of shares each player owns of each stock, dividends received for that year by each player, and the new cash total of each player. Every player then has the opportunity to sell and/or buy any shares he desires. The "official" stock abbreviations as printed at the beginning of the program are used to select what stocks are bought or sold and the program will not accept incorrect abbreviations. If a player tries to sell shares

Table 1: All stock and security names are purely fictitious; any resemblance to a real life company or firm was not intentional. A brief description of each stock follows:

HIGHWAY IMPROVEMENT BONDS — YIELD 5%

An excellent state bond with good security and income potential, but no appreciation.

X-PANDO CORPORATION — YIELD 1%

A rapidly expanding industrial firm that reinvests most earnings on research, causing low yield. The price-to-earnings ratio is extremely high.

SEASIDE PROPERTIES INC — NO YIELD

Good appreciation prospects but no dividends. In the immediate future, however, the proposed beach cleanup program could have great effect on earnings.

OLD DOG MUTUAL FUND — YIELD 4%

A common stock mutual fund that represents a good, steady income, with only fair appreciation.

RUBBLE DEVELOPMENT — YIELD 7%

A high income real estate investment with steadily depreciating capital assets.

SLIPPERY OIL COMPANY — NO YIELD

Very speculative investment since profits go toward new oil wells. No dividends are expected.

BUMPY TRANSPORT COMPANY — NO YIELD

High appreciation investment with a good outlook depending on the administrative ability of its new board of directors. No dividends are expected since all profits are recycled into the company.

KRASH AUTO COMPANY — YIELD 2%

A medium size auto company representing a somewhat speculative investment. It has a fairly high price-to-earnings ratio with a low yield.

ZAP ELECTRONICS INC — YIELD 6%

A highly speculative, high income stock with a fair to poor long term prospect.

BLINKEY POWER AND LIGHT — YIELD 3%

A steadily growing utility company in an established industrial area.

```
00540   DATA   18,23,11,12,46,18,-5,34,15
00550   DATA   23,28,-2,11,56,19,30,29,14
00560   DATA   20,15,15,7,-20,15,13,-10,12
00570   DATA   17,21,13,-2,37,23,23,19,14
00580   DATA   19,24,17,9,-5,26,13,-7,15
00590   DATA   11,18,14,11,67,15,22,18,13
00600   DATA   13,31,1,14,-11,18,18,-14,10
00610   DATA   14,-8,19,-1,-9,25,-10,13,19
00620   DATA   24,24,23,20,51,27,38,33,18
00630   DATA   12,14,13,10,10,20,21,25,8
00640   DATA   7,-6,10,-10,30,6,-19,22,-2
00650   DATA   9,10,7,-5,-20,12,21,18,7
00660   DATA   7,8,5,-6,-40,3,16,-14,4
00670   DATA   8,6,4,-4,40,8,4,-12,3
00680   DATA   6,4,3,3,-15,5,8,-8,5
00690   DATA   5,7,-1,-3,45,6,-10,10,4
00700   DATA   -2,6,-3,-8,-20,7,10,14,6
00710   DATA   11,11,-5,-7,30,10,-11,-18,-4
00720   DATA   -5,13,-8,6,25,4,18,-22,-4
00730   DATA   -8,-10,-10,-15,-20,-20,-23,-25,-7
00740   DATA   5,1,0,4,7,0,0,2,6,3
00750
00760   REM    SECURITY NAMES
00770
00780   DATA   "HIGHWAY IMPROVEMENT BONDS"
00790   DATA   "X-PANDO CORPORATION"
00800   DATA   "SEASIDE PROPERTIES INC."
00810   DATA   "OLD DOG MUTUAL FUND"
00820   DATA   "RUBBLE DEVELOPMENT"
00830   DATA   "SLIPPERY OIL COMPANY"
00840   DATA   "BUMPY TRANSPORT CO."
00850   DATA   "KRASH AUTO COMPANY"
00860   DATA   "ZAP ELECTRONICS"
00870   DATA   "BLINKEY POWER & LIGHT CO."
00880
00890   REM    ABBREVIATIONS
00900
00910   DATA   "HIB","XP","SP","ODM","RD","SO","BT","KA","ZE","BPL"
00920
00930   REM    DIVIDENDS
00940
00950   DATA   "$5","$1","NONE","$4","$7","NONE","NONE","$2","$6","$3"
00960
00970
00980   PRINT "WANT INSTRUCTIONS (Y OR N)";
00990   INPUT R$
01000   IF R$="N", GO TO 1280
01010   IF R$<>"Y", GO TO 990
01020   PRINT
01030   PRINT "THE MAIN OBJECT OF BLACK FRIDAY IS TO SHREWDLY INVEST $5,000"
01040   PRINT "IN THE GAME'S 10 SECURITIES, BUYING AND SELLING EACH YEAR FOR"
01050   PRINT "A MAXIMUM OF 10 YEARS (ROUNDS) IN AN ATTEMPT TO BECOME"
01060   PRINT "THE WEALTHIEST PLAYER."
01070   PRINT
01080   PRINT "EACH YEAR ALL PLAYERS WILL RECEIVE DIVIDENTS ON EVERY PAYING"
01090   PRINT "STOCK WHICH IS WORTH $50 OR MORE. THEN EACH PLAYER WILL"
01100   PRINT "GET A CHANCE TO SELL ANY STOCKS HE OWNS OR BUY ANY STOCKS"
01110   PRINT "HE WISHES. AT THE END OF THE SELECTED NUMBER OF YEARS,"
01120   PRINT "EACH PLAYER'S NET WORTH WILL BE CALCULATED AND THE WEALTHIEST"
01130   PRINT "PLAYER WINS!"
01140   PRINT
01150   PRING "IF THE VALUE OF ANY STOCK FALLS TO 0, THAT STOCK GOES BANKRUPT"
01160   PRINT "AND ALL SHARES ARE SURRENDERED.  THE VALUE OF THE STOCK IS THEN"
01170   PRINT "ESTABLISHED AT $100.  IF THE VALUE OF ANY STOCK REACHES $150,"
01180   PRINT "THERE WILL BE A STOCK SPLIT.  ANY PLAYERS OWNING SHARES OF THAT"
01190   PRINT "STOCK WILL RECEIVE THE EXTRA SHARES.  THE VALUE OF THE STOCK IS"
01200   PRINT "HALVED (ROUNDED UP TO THE NEXT HIGHEST DOLLAR)."
01210   PRINT
01220   PRINT "A TABLE WILL BE PRINTED EACH YEAR GIVING THE CHANGE IN VALUE"
01230   PRINT "OF EACH STOCK, THE CURRENT PRICE, AND THE NUMBER OF SHARES"
01240   PRINT "EACH PLAYER OWNS OF EVERY STOCK.  ALSO, ANY DIVIDENDS RECEIVED"
01250   PRINT "FOR THE YEAR WILL BE SHOWN ALONG WITH EACH PLAYER'S TOTAL CASH."
01260   PRINT
01270   PRINT "****** GOOD LUCK TO EVERYONE! ******"
01280   PRINT
01290   PRINT "AVAILABLE SECURITIES, ABBREVIATION, DIVIDENDS PER SHARE"
01300   PRINT
01310   FOR N=1 TO 10
01320   PRINT S$(N),V$(N),Y$(N)
01330   NEXT N
01340   PRINT
01350   PRINT "NUMBER OF PLAYERS (1 TO 4) = ";
01360   INPUT P
01370   IF P>4, GO TO 1360
01380   IF P<=0, GO TO 1360
01390   MAT M=ZER
01400   PRINT
01410   PRINT "NUMBER OF YEARS (3 TO 10) = ";
01420   INPUT S
01430   IF S<3, GO TO 1420
01440   IF S>10, GO TO 1420
01450   MAT F=ZER
01460   FOR N=1 TO P
01470   LET M(N,1)=5000
01480   NEXT N
01490   MAT T=CON
01500   MAT T=(100)*T
01510   LET Y=0
01520
01530
01540   REM    FIND MARKET CHANGES FOR NEXT ROUND, SEE IF BULL OR BEAR MARKET
```

```
01550
10560    LET D=INT(11*RND+1)
01570    LET C=INT(36*RND+1)
01580    IF A(C,12)=1, GO TO 1570
01590    LET A(C,12)=1
01600    FOR N=2 TO 10
01610    IF A(C,1)=1, GO TO 1660
01620    LET W$="BEAR"
01630    LET F(N-1)=A(C,N)+E(D,N-1)
01640    LET T(N)=T(N)+F(N-1)
01650    GO TO 1720
01660    LET F(N-1)=A(C,N)+U(D,N-1)
01670    LET W$="BULL"
01680    LET T(N)=T(N)+F(N-1)
01690
01700    REM        CHECK FOR STOCK SPLITS
01710
01720    IF T(N)<150, GO TO 1840
01730    PRINT "*** "+S$(N)+" STOCKS SPLIT ***"
01740    IF T(N)/2=INT(T(N)/2), GO TO 1770
01750    LET T(N)=INT(T(N)/2)+1
01760    GO TO 1780
01770    LET T(N)=T(N)/2
01780    FOR J=1 TO P
01790    LET M(J,N+1)=M(J,N+1)*2
01800    NEXT J
01810
01820    REM        CHECK FOR BANKRUPT STOCKS
01830
01840    IF T(N)>0, GO TO 1910
01850    LET T(N)=100
01860    FOR J=1 TO P
01870    LET M(J,N+1)=0
01880    NEXT J
01890    PRINT "*** "+S$(N)+" WENT BANKRUPT ***"
01900    PRINT "THESE STOCKS MUST BE SURRENDERED"
01910    NEXT N
01920    LET Y=Y+1
01930
01940    REM        ADD EACH PLAYER'S DIVIDENDS TO TOTAL CASH
01950
01960    FOR N=1 TO P
01970    LET M(N,12)=0
01980    FOR J=1 TO 10
01990    IF T(J)<50, GO TO 2010
02000    LET M(N,12)=M(N,12)+(I(J)*M(N,J+1))
02010    NEXT J
02020    IF A(C,11)=0, GO TO 2050
02030    LET M(N,12)=M(N,12)+(M(N,3)*2)
02040    PRINT "*** X-PANDO CORP. PAYS $2 DIVIDENDS PER SHARE ***"
02050    LET M(N,1)=M(N,1)+M(N,12)
02060    NEXT N
02070
02080
02090    REM        PRINT WHAT HAPPENED & CURRENT VALUES
02100
02110    PRINT
02120    PRINT "*** YEAR ";Y;" *** "+W$+" MARKET ***"
02130    PRINT
02140    PRINT SPACE$(23)+"PLAYER - HOLDINGS"
02150    PRINT
02160    PRINT SPACE$(6)+"+/-$       PRICE";
02170    FOR N=1 TO P
02180    PRINT SPACE$(5);N;
02190    NEXT N
02200    PRINT
02210    PRINT
02220    PRINT V$(1)+SPACE$(4)+"0"+SPACE$(7)+"100"+SPACE$(7);
02230    FOR N=1 TO (P-1)
02240    PRINT STR$(M(N,2))+SPACE$(8-LEN(STR$(M(N,2))));
02250    NEXT N
02260    PRINT STR$(M(P,2))
02270    FOR N=1 TO 9
02280    PRINT V$(N+1)+SPACE$(7-LEN(V$(N+1)));
02290    PRINT STR$(F(N))+SPACE$(8-LEN(STR$(F(N))));
02300    PRINT STR$(T(N+1))+SPACE$(10-LEN(STR$(T(N+1))));
02310    FOR J=1 TO (P-1)
02320    PRINT STR$(M(J,N+2))+SPACE$(8-LEN(STR$(M(J,N+2))));
02330    NEXT J
02340    PRINT STR$(M(P,N+2))
02350    NEXT N
02360    PRINT
02370    PRINT "DIVIDENDS FOR YEAR"+SPACE$(7);
02380    FOR N=1 TO (P-1)
02390    PRINT STR$(M(N,12))+SPACE$(8-LEN(STR$(M(N,12))));
02400    NEXT N
02410    PRINT STR$(M(P,12))
02420    PRINT
02430    PRINT "NEW CASH TOTAL"+SPACE$(11);
02440    FOR N=1 TO (P-1)
02450    PRINT STR$(M(N,1))+SPACE$(8-LEN(STR$(M(N,1))));
02460    NEXT N
02470    PRINT STR$(M(P,1))
02480    IF Y=S, GO TO 2990
02490
02500
02510    REM        CHECK IF ANYONE WANTS TO SELL OR BUY ANYTHING
02520
02530    FOR N=1 TO P
02540    PRINT
02550    PRINT "*** PLAYER ";N;" ***"
```

he doesn't own, the program will indicate how many shares he actually has. When a player buys shares, the program will indicate how much money he actually has if the player doesn't have enough to buy the specified number of shares. After every transaction the program will indicate the player's new cash total.

At the end of the predetermined number of years (rounds), the game ends and the program will print out each player's net cash worth.

I hope you have as much fun playing this game as I did writing it. I would suggest, however, using a hardcopy terminal rather than a video terminal, due to the length of the yearly tables.■

```
02560    PRINT
02570    PRINT "YOU NOW HAVE $";M(N,1)
02580    FOR J=1 TO 10
02590    IF M(N,J+1)<>0, GO TO 2620
02600    NEXT J
02610    GO TO 2770
02620    PRINT "DO YOU WANT TO SELL ANY SHARES (Y OR N)";
02630    INPUT R$
02640    IF R$="N", GO TO 2760
02650    IF R$<>"Y", GO TO 2630
02660    GOSUB 3160
02670    PRINT "NUMBER OF SHARES SELLING";
02680    INPUT R
02690    IF R<=M(N,J+1), GO TO 2730
02700    PRINT "*** YOU ONLY HAVE ";M(N,J+1);" SHARES ***"
02710    GO TO 2670
02720    PRINT
02730    LET M(N,J+1)=M(N,J+1)-R
02740    LET M(N,1)=M(N,1)+(R*T(J))
02750    GO TO 2560
02760    PRINT
02770    FOR J=1 TO 10
02780    IF M(N,1)>T(J), GO TO 2810
02790    NEXT J
02800    GO TO 2950
02810    PRINT "DO YOU WANT TO BUY ANY SHARES (Y OR N)";
02820    INPUT R$
02830    IF R$="N", GO TO 2950
02840    IF R$<>"Y", GO TO 2820
02850    GOSUB 3160
02860    PRINT "NUMBER OF SHARES BUYING";
02870    INPUT R
02880    IF R*T(J)<=M(N,1), GO TO 2910
02890    PRINT "*** YOU DON'T HAVE ENOUGH MONEY FOR ";R;" SHARES ***"
02900    GO TO 2860
02910    LET M(N,J+1)=M(N,J+1)+R
02920    LET M(N,1)=M(N,1)-(R*(T(J)))
02930    PRINT "YOU NOW HAVE $";M(N,1)
02940    GO TO 2760
02950    NEXT N
02960    GO TO 1560
02970
02980
02990    REM        CLOSING OUT AT END OF GAME - PRINT FINAL TOTALS
03000
03010    PRINT
03020    PRINT
03030    PRINT "*** FINAL TOTALS ARE:"
03040    PRINT
03050    PRINT "PLAYER"+SPACE$(10)+"TOTAL"
03060    FOR N=1 TO P
03070    FOR J=1 TO 10
03080    LET M(N,1)=M(N,1)+(T(J)*M(N,J+1))
03090    NEXT J
03100    PRINT
03110    PRINT USING " ###        $$$$,,,,,,,,",N,M(N,1)
03120    NEXT N
03130    STOP
03140
03150
03160    REM        SUBROUTINE TO LOOK UP STOCK NAMES FOR BUY & SELL
03170
03180    PRINT "NAME OF STOCK";
03190    INPUT R$
03200    FOR J=1 TO 10
03210    IF R$=V$(J), GO TO 3240
03220    NEXT J
03230    GO TO 3190
03240    RETURN
03250
03260    END
```

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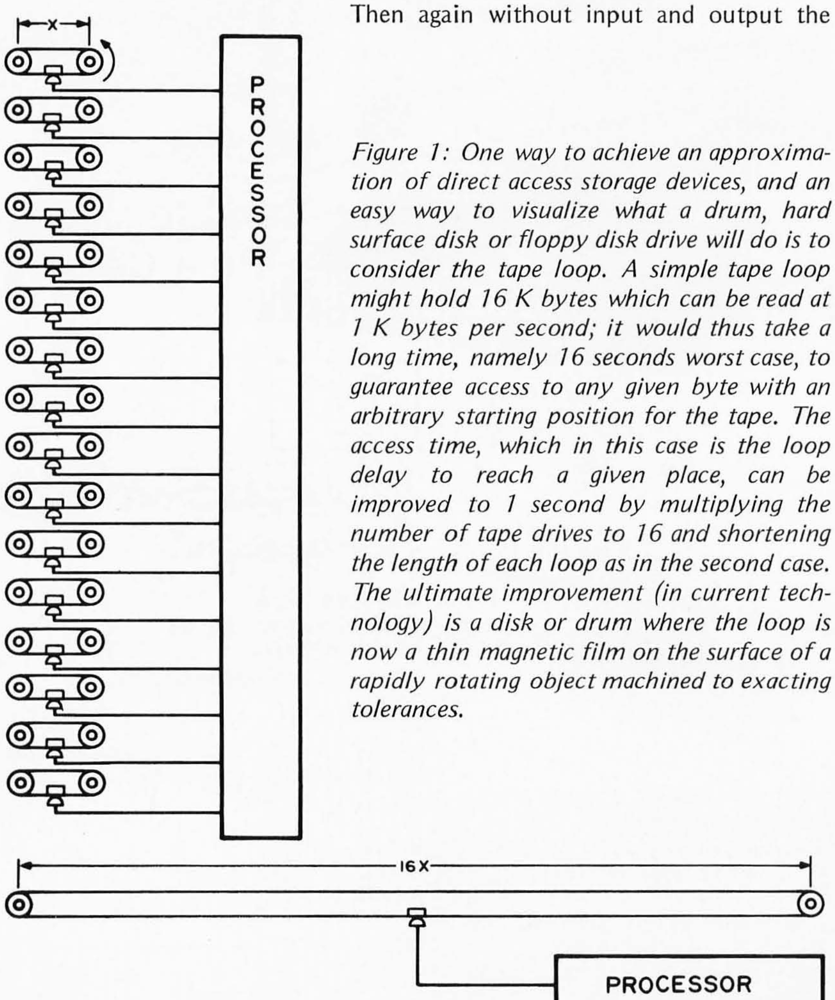
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The Types and Uses of Direct Access Storage

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Why They Are Essential

What is the most important part of a computer system? Well, this is a difficult or impossible question to answer, but let us look at the components. Of course, there will have to be a processor, and this selection will affect the potential of the system; but a processor alone is just expensive junk. There will also have to be main memory; generally the more of it and the faster it is the better. Then again without input and output the processor and memory will sit idle. Some type of storage that can contain large volumes of data or programs is also necessary so that everything need not be entered through the slow interactive IO channels every time the system is used. The mass storage device is often a tape unit; for small scale people like us this means an audio or digital cassette or even paper tape unit; for large scale systems this also includes larger, more sophisticated units using standard 1/2 inch (1.27 cm) computer tape. The category of mass storage also includes Direct Access Storage Devices (if you see the acronym DASD, you know what it means now). If you buy a system from one of the large manufacturers it may or may not come with a tape unit of some type, but it will almost always come with some direct access storage device. Why is this?

Figure 1: One way to achieve an approximation of direct access storage devices, and an easy way to visualize what a drum, hard surface disk or floppy disk drive will do is to consider the tape loop. A simple tape loop might hold 16 K bytes which can be read at 1 K bytes per second; it would thus take a long time, namely 16 seconds worst case, to guarantee access to any given byte with an arbitrary starting position for the tape. The access time, which in this case is the loop delay to reach a given place, can be improved to 1 second by multiplying the number of tape drives to 16 and shortening the length of each loop as in the second case. The ultimate improvement (in current technology) is a disk or drum where the loop is now a thin magnetic film on the surface of a rapidly rotating object machined to exacting tolerances.

First of all what is a direct access storage device? It is generally any mass storage unit where data can be accessed somewhat randomly and without reading all the data that comes before it in the file. Clear enough? Well, let's look at an example. Suppose attached to a processor with some amount of memory and IO there are 16 cassette tape recorders. Each cassette has a tape loop in it that can hold 1 K bytes and the data rate is 1 K bytes per second. Also the tapes are always running. These 16 tapes are functionally equivalent to one form of direct access storage device, so let us compare them to one tape cassette which can contain 16 K bytes with the same speed. If any data is needed the maximum delay with the 16 units is one second, with the single tape 16 seconds. Since the processor has to wait (and maybe so do you) while the data is found, this significantly affects the time it takes to do the IO operation, and the time it takes to complete your job. Besides, what do you do if you have a program with more than one "simultaneous" input or output? There is no

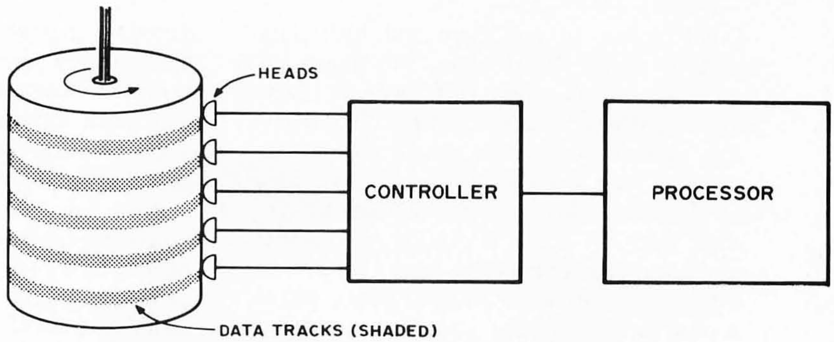


Figure 2: The drum drive is usually implemented with fixed heads, with one set of heads per track. The capacity of a drum drive might be as little as 50,000 bits or so, or a number extending into the millions of bytes in large scale systems. For the amateur, drum drives may occasionally be found in surplus stores, but documentation and technical pointers may be hard to find.

easy (or fast) way around that problem with the single cassette, but the problem is trivial with the 16. The only disadvantage is, of course, the investment in those other 15 endless loop tape drives. Fortunately one direct access storage device is cheaper than the equivalent number of tape devices, so let's take a look at the available types.

Drums

The three types of direct access storage devices I am going to mention are not the only types but are the most likely to be available in new or surplus form to small scale computer people like us. The first and oldest type is the drum. This is a metal cylinder coated with a magnetic oxide, as on recording tape. It rotates on its axis at a high rate of speed. Placed along the outer surface of the rotating drum are the read and write heads which move the data on and off the drum surface. Since the heads themselves do not move they repeatedly scan a fixed band around the outside of the drum called a track. The entire outer surface of the drum is divided into many tracks, each of which has its own particular read and write head(s). Therefore if you want to read or write data anywhere on the drum the most you have to wait is one revolution. An expensive drum might contain around four million bytes, perhaps a hundred or so tracks. The maximum wait time, sometimes called "latency," might be about 9 ms. This capacity is of course larger than is available to most experimenters but should give some idea of what can be done with the drum.

Disks

Another type of direct access storage device is the disk, which can be considered a variation of the drum. Instead of a drum consider a disk like a record, and the heads are above the surface of the disk. Now the tracks are concentric circles instead of bands; other than that, the fixed head disk is very similar to a drum. On both the hard surface disk and drum the heads do not actually touch the rigid surface because of the wear involved, but instead are positioned to "fly" 50 to 250 micro inches from the surface. A variation of hard surface disks, which is the most common, is a moving head version. To prevent these flying heads from crashing, both kinds clearly require precision manufacture.

The last type to be mentioned is the floppy disk. Here the disk is made out of recording tape material and is thus not rigid, hence the name. Since the disk is flexible the heads actually touch the recording surface like a tape recorder and yet head wear is not such a problem although the disk itself does wear out. On the drum and hard surface disk the drum or disk is often permanently mounted or comes in an expensive removable cartridge form; but on the floppy disk, the disk is a low cost (~ $10) item which can be changed in a matter of seconds. This allows inexpensive offline storage while retaining direct access for mounted cartridges. There is one more wrinkle; the floppy disk units have only one read/write head and a head positioner which moves the head to select the track as in a traditional moving head hard surface disk. The tracks are still concentric and not spiral as in a phonograph record. This means that an additional delay is entered into the system, since while the arm positioner is moving there cannot be any read or write operations going on. The capacity of available floppies has been about 250 K to 300 K bytes; recently, however, double density floppy disks have been introduced and the prices have been going down. Another recent innovation is the even lower priced "mini" floppy drives.

What do these devices have in common?

Quick access to any item and high data transfer rates. What does this mean to someone programming the system? Each track can be considered a separate addressable place to store data, which means that you can have many logically different files on just one direct access storage device. Also, since the access is quicker, the processor waits less and works more, better utilizing your hardware. In most cases, direct access storage device can be considered intermediate between main memory and the slower mass storage of a serial magnetic tape. Memory is fast and also much more expensive, so the capacity in a system is generally low. Cassette storage has very large capacity and is inexpensive, but like all serial media it is much slower than either memory or direct access devices. Direct access devices are between the memory and serial devices in speed, price, and capacity. Therefore such devices can be considered slow memory (somewhat) or fast mass storage. So let us see how they are used.

What if you just wrote a nifty new program that runs in 16 K but your system only has 8 K to spare? Do you buy another 8 K before you run this? Of course not. You logically break the program into smaller pieces, which are stored in a direct access device. When your application comes to need a program segment which is not in main memory, it goes out to the direct access storage device and loads the needed segment. Since the maximum delay of an inexpensive floppy unit is about 0.75 second and it has a data rate of 250 K bytes per second, there will be little pause before the program is again executing. Further, most of the delay is from arm positioning motions, so if all the data and program segments are on adjacent tracks the delay will typically average less than 1/30 of a second. Even if a person is waiting for the results, a large amount of such swapping can go on before the wait gets excessive.

What else should the direct access device be used for? A good thing to put on such devices is program libraries. These are generally of two types: source and object libraries. The source library has source programs, which are the programs in their original text form, such as a BASIC or FORTRAN program. This allows you to maintain a program for a long time and modify it as necessary at the source level, without bit twiddling. The object library contains programs in machine language. The object programs are the output of compilers or assemblers; object programs are typically ready to be loaded and executed. This is handy in that you do not have to compile the program every time it needs to be executed. Compiled or assembled code is also much more efficient than the interpretive execution (which literally "compiles" every time, "on the fly").

Now let's look at a macro assembler that produces object code. This is a fairly sophisticated assembler where all operands are defined symbols (no more worrying about actual addresses). Now suppose someone sits down and wants to assemble a program. They first tell the system monitor to get the assembler, which it does from an object library. Before a substantial time lapse has been perceived by the programmer, the assembler returns notice that it is ready to proceed. The programmer then enters source statements through the terminal. In memory is the part of the assembler that checks the validity of the statements entered. If a macro reference is entered it will go search a separate "macro library" of source text for a "macro" which is merged with the text. Besides this it writes out the source listing to another source library file and makes a symbol table which is eventually written out to a temporary file. When the programmer is done the second stage of the assembler is loaded and assembles the code. It loads the machine code in the object library and then a resident loader brings the machine language code in on top of where the assembler was and starts the execution of the program. Because of the high speed of current processors and direct access devices, the programmer may be just starting to contemplate what a slick program he or she has written, when it blows up during execution. Well, better luck next time; but remember this: The source and object versions still exist, and if your system software is protected and all IO is done through the system (ie: your libraries are protected) then you have not wasted all this time. Dump the memory used onto the direct access device and forget about it tonight. Tomorrow with a fresh mind you can work the source listing and the dump and figure out what happened. Chances are that by modifying three or four source statements the program can be rid of the bug.

One of the biggest uses of the direct access storage devices is information storage and retrieval. Whole books have been written on this one subject alone. This is a generalization of the problem of storing and filing programs, to extend into other areas. For instance, if you are the proprietor of a business, and want to use your computer to keep track of all your customers, with

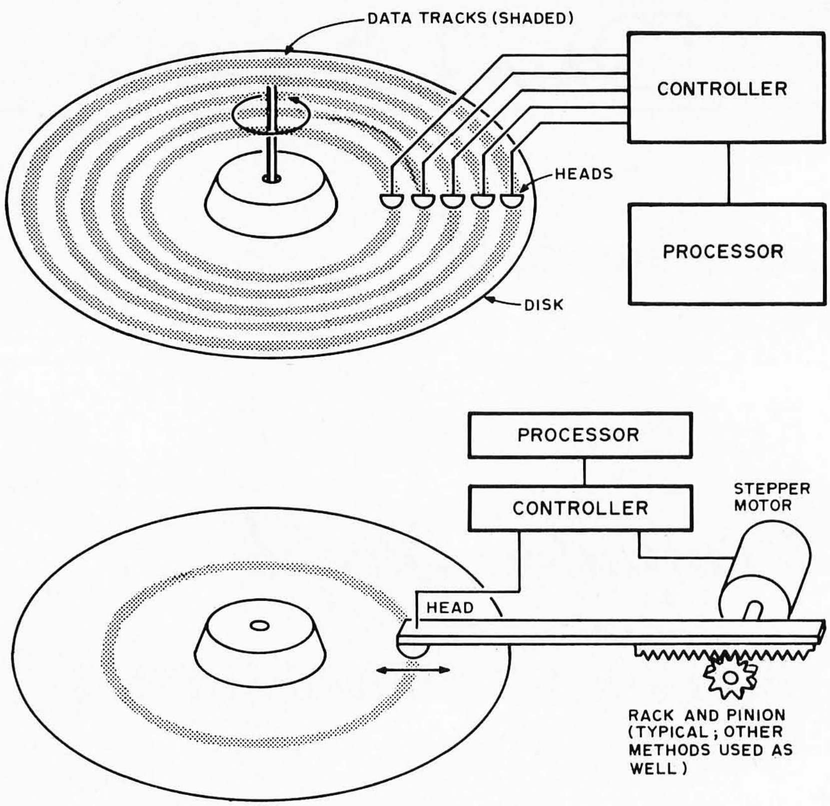


Figure 3: The personal computing enthusiast is most likely to have an encounter with disk direct access storage devices. The expensive kind have hard surfaces rotating at high speed; some expensive versions are built to last "forever" with fixed heads in hermetically sealed housings; others are the conventional data processing drives with expensive cartridges for removable media containing one or more hard rigid platters. The most likely drive for the amateur is the floppy disk, a miniaturized version of the disk drive which uses flexible media like a tape recorder, a moving arm run by a stepper motor or similar mechanism, and can hold about 250 K bytes in the original form, 100 K bytes in the newer, less expensive "mini" floppies.

perhaps 300 bytes of information per customer, then you would almost certainly want a direct access storage device with your computer. Why? Well, suppose that you had 200 customers. To find the file on any one of those customers requires distinguishing a mere 300 bytes out of a set of 200 * 300 = 60,000 bytes. If all that data were to be kept in main memory, you would have to buy 60,000 bytes, and you could lose your data if the power failed. It might cost $300 per 8 K board of memory (probably more) for the purchase of enough programmable semiconductor memory for this amount of data, or at least $1500. With conventional small systems, this would use up the address space if all space were required for data, leaving no room for programs. In contrast, by using just one conventional floppy drive costing approximately $1000 to $1500 by the time it's interfaced, 200,000 to 300,000 bytes can be on line with 1/4 to 1/2 second access, and the actual main memory requirements in the machine for typical applications would be reduced, probably to the 16 K to 20 K range if an 8 K extended BASIC interpreter is used. But the data need not be just this one kind of data, and removable media can be stored for backup purposes. Thus the actual functions of the system have been considerably improved when such a storage device is added. The conclusion is that if at all possible, a system should have a floppy disk or its equivalent, the direct access storage device.

The point I have been making is that direct access storage is essential to convenient and efficient use of a computer system. A computer's potential may be largely wasted without good IO. I contend that a lowly 8008 processor with 16 K bytes and 300 K byte floppy disk will outperform an LSI-11 with 16 K words and 300 K bytes of serial cassette as a general purpose system. The LSI-11 is more than 10 times as fast as a processor, has a much much better instruction set, twice as much memory, and uses its memory better; but nevertheless most of the time it will be waiting on IO from the cassette. A waiting processor is a wasted processor. There is not even much price difference in the two systems; it is just where the money is spent. My moral is: Get the least expensive processor that you can and spend the rest of your money on direct access storage.

The final thing we have to look at is where to get DASD? This is unfortunately a sore point because they are still relatively expensive. MITS and several of their competitors have floppies in the neighborhood of $1000 for 300 K bytes. These prices should decline as demand allows for quantity purchases, just as the prices of chips have fallen. Lately Calcomp (24111 W. LaPalma Av, Anaheim CA 92801) has introduced the 142 double density floppy disk which has a capacity of 802 K per disk. Although these people are not out for the amateur market, it is not hard to believe that a distributor who is after the amateur market will offer them in sale. Other than that, it starts to get tricky. The used computer equipment markets and surplus markets are a good bet for drums, fixed head disks, and floppies; but the chore of interfacing is clearly with the buyer. On these markets there are tremendous bargains and there are also units without specifications and nearly worn out, so the buyer has to be careful. Overall the situation is not good, either expensive or risky. One of the goals of

this article is to stimulate awareness and demand of direct access storage devices and thus to bring prices down, as we all have seen happen with processors and other chips.

When should you spend the extra bucks for direct access devices and not for cheaper mass storage? The answer is when your computer system is not fast enough. If you do not care how long it takes the system to perform any one task, then you certainly need not buy direct access devices. I personally demand that my computer system should be able to do significant amounts of work on an interactive basis, and I do not like to wait excessive amounts of time for slow peripherals. Also I generally find that I can keep the machine busy even if I am not at the terminal.

In conclusion, the properties of the direct access device include the ability to randomly access data on the device and high data transfer rates. This allows the device to be treated as either slow memory or fast mass storage. Without direct access devices, the processor speed may be a relatively unimportant component of total system speed if time is spent waiting for slow devices.■

GLOSSARY

Compiler: A program that takes source language statements and translates them into machine language. This is the object program which is executed separately from the compiler.

DASD: Direct Access Storage Device.

Interpreter or interpretive compiler: A program that takes source language statements as input and executes them directly after interpreting the meaning.

IO: Input or output, or both.

K: 1024.

Macro: A segment of prewritten source code that performs a commonly used function. In a macro assembler, a macro is invoked by the use of its name, in which case the prewritten statements are inserted in replacement for the macro name.

Main memory: Core or solid state electronic storage.

Mass storage: A device that can contain a large amount of data, ie: a cassette tape, paper tape, or direct access device.

Object program: A program in machine language ready for execution, or loading then execution.

Source program: A program in the original language which is input to a compiler or interpreter, as in a FORTRAN or BASIC program.

System: The sum and total of the processor, memory, IO, mass storage, and software.

SYS 8½...

Your Own Executive Commands

Willard I Nico
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Houston TX 77043

Every time I get something new, I take it apart to see how it works and what I can change to make it work better for my use. My analyst says, "Don't worry! Boys are always taking clocks and radios and toasters apart." Well, that's a fine excuse for boys, but I'm pushing 32 H and still taking things apart . . . so I worry! Once in a while though, I come up with what I think is a pretty good idea; like when I got my IMSAI computer running and started taking apart the software they sent with it.

The program, called SYS 8, is a self contained operating system for 8080 based microprocessors. It has a system monitor, text editor, and assembler and really "runs the whole show." The software was written by a company called Microtec in Sunnyvale CA and comes free with the IMSAI. Processor Technology Co supplies a virtually identical version as the Software Package #1. Except for a modest copying charge, they give it away free also. If you have an 8080 computer, you should have a copy of SYS 8. It works fantastically well, and you have to agree that the price is right!

Table 1: A list of the executive commands and their functions that are implemented in the SYS 8 monitor as it is supplied by IMSAI and Processor Technology. The table gives the hexadecimal starting locations in both the IMSAI and Processor Technology systems.

Mnemonic	Starting Address		Function
	IMSAI	ProcTech	
DUMP	033B	F29B	Display contents of a block of memory
EXEC	0154	F089	Execute a program in memory
ENTR	04C1	F437	Enter data in memory
FILE	0389	F2FF	List data files; create or delete files
LIST	060E	F584	List program in current data file
DELT	0627	F5E1	Delete program lines
ASSM	0700	F658	Assemble current assembly language program into object code
PAGE	036D	F2D8	Move 256 bytes of memory data
CUST	2000	E000	Execute program at specified address
BREK	070C		Set or clear breakpoint
PROC	070F		Proceed from breakpoint
PROM		F59D	Program a PROM

Executive Commands

Assuming that you have rushed out and obtained a copy of SYS 8, you are now aware that there are a number of executive commands implemented, which you can call up by typing a four letter mnemonic on your keyboard. Table 1 lists the commands and what they do.

Notice particularly the CUST command. Typing CUST signals the monitor to begin execution of your own special program which you have placed in memory at the address they give you in the software documentation. This is a handy way to branch out of the monitor and run your own programs. It's so handy in fact that I began wishing they had provided not only CUST, but CUST1, CUST2 and so on through CUST(N) so that I could run lots of different programs of my own by just typing a descriptive four letter command.

I have several routines that I use so regularly that they are just as resident in my system as any of the commands implemented in SYS 8. You probably have programs that punch tape, load machine code programs, calculate hexadecimal arithmetic and others that you use so often that it

would be a great operating convenience to be able to whistle them up from the system monitor with a mnemonic.

Taking the SYS 8 software apart really paid off. I found that I could add all the executive commands I wanted. You can too! I'll tell you how to modify the system monitor program to recognize your custom four letter command mnemonics and branch to the proper memory address to execute the desired program.

Since the IMSAI and Processor Technology versions of SYS 8 are so similar, the instructions apply to both programs. However, the memory addresses are different. When we need to refer to a hexadecimal address in the SYS 8 program, we'll use the format IIII/PPPP, where IIII is the IMSAI program address and PPPP is the Processor Technology address. The IMSAI documentation I have is revision 1 plus errata dated March 4 1976. The Processor Technology version is not dated, but is given as "Microtec Macro Assembler Ver 3.1."

How SYS 8 Works

Each line of characters you type in on your keyboard is stored in an area of memory called the input buffer. When you type a carriage return, entry into the buffer is terminated and the SYS 8 monitor reads the data in the input buffer to find out what it is that you want to do.

The monitor makes an important decision based on the first character in the buffer. If that character is one of the numerals 0 through 9, the monitor assumes that the entire line is data for the current assembly language program file. A branch is made to the routines that add lines to the file or replace existing lines. If the first character in the buffer is not a number, the program branches to the executive command routines. This is the part we are interested in dissecting.

The monitor maintains a table of executive commands which it will recognize by four letter names. The table is called CTAB, and is located at address 02F1/F257. When the program has branched to the command processing routines, the first four characters in the input buffer are compared to each entry in CTAB. When a match is found, the computer JuMPs to the address specified by the next two bytes in CTAB, and the special program is off and running. After a specific number of tries at finding a match in CTAB without success, the error "WHAT?" is printed and you have to start over.

Each entry in CTAB consists of a four letter program name and two bytes specifying the address where the named program begins. By simply adding entries to CTAB in the proper format, we can extend the repertoire of keyboard invoked, named programs by as many as we wish.

Adding Your Own Executive Commands

In the SYS 8 program, CTAB occupies memory locations 02F1/F257 through 0332/F292. The only thing keeping us from adding commands to the current table is the fact that it is hemmed in on both sides by the BID1 and VCHK subroutines. Clearly, either the table or the subroutines have to be moved. Moving CTAB is far easier than finding and changing all the subroutine references. So pick a spot for the new location of CTAB and give yourself lots of room so that more commands can be added as you develop new routines and programs that you want at your fingertips.

Each entry that you add to CTAB will consist of six data bytes. The first four are the ASCII characters of the command name, such as DUMP, and the next two bytes are the high and low address of the beginning of the named program or routine. Note that the high address is first, then the low address in the Processor Technology version; and low address first then high address in the IMSAI version.

Suppose you have a routine named FINK starting at address 0A74 and wish to add it to the command list. The CTAB entry would be:

ProcTech	46	49	4E	4B	0A	74
IMSAI	46	49	4E	4B	74	0A

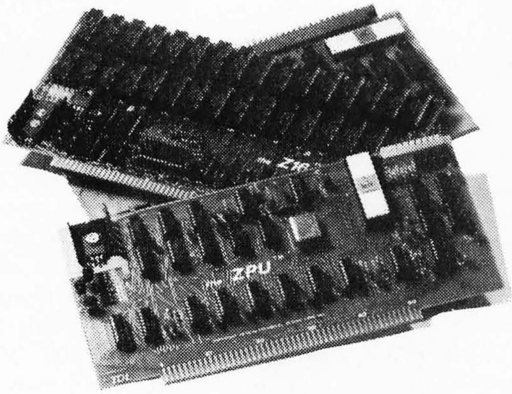
Making It Work

Two changes must be made in the monitor program to implement the new location and length of CTAB.

The first change is at location 015E/F0C3. The instruction is LXI D, CTAB and references the old location 02F1/F257. Change the data in bytes 015F/F0C4 and 0160/F0C5 to give the address of the beginning of the new location of CTAB. (Don't forget that the low address comes first!)

The second change required is at location 0162/F0C7. The MVI B, NCOM instruction loads the B register with the number of legal commands in the table. The COMS routine searches the table for a match between the command name you have typed and the entries in the table. The search is abandoned and the WHAT? error message printed if a match cannot be found after NCOM tries.

You have two alternatives as to selection of the new value for NCOM. You can use the current number of CTAB tries and change the number each time you add to the table,


ZPU

Macro Assembler
BASIC
TEXT EDITOR
2K MONITOR

	Parameter	
	First	Second
ABUF	107E/DO5A	1082/DO5E
BBUF	108A/DO66	108C/DO68

Table 2: Listing of hexadecimal addresses of parameter storage locations ABUF and BBUF. The addresses are given in the form IIII/PPPP, where IIII stands for the address in the IMSAI version and PPPP stands for the address in the Processor Technology version of the SYS 8 monitor.

or you can reserve space for the current length of CTAB plus all the additional entries you think you will ever need and use this future maximum number as NCOM. In the latter case, just be sure to fill CTAB unused locations with hexadecimal 0 bytes so that there is no chance for a false match.

Pass the Parameters Please!

When you have moved CTAB, changed the code in the monitor as we have described, and added some of your own executive commands, you are ready to discover another handy feature of the SYS 8 monitor: parameter passing.

As we have already seen, we now have the capability to create our own executive commands. As an example, suppose we have a program that will enter the code hexadecimal 00 in a block of memory locations. We call the program ZERO and add it to the command table. In order to execute the program, we type ZERO on the keyboard and then a carriage return; the rest is done automatically.

However, we can make the program easier to use if the limits of the block of memory to be zeroed can be specified along with the executive command. If we wish to zero the block of memory from A100 through A1FF, it would be nice to be able to enter the command:

ZERO A100 A1FF

Specifying data to be passed along to the service routine in this manner is called parameter passing and can be easily implemented with the SYS 8 monitor.

As we have mentioned, a complete line of keyboard input is stored in the input buffer before any action is taken by the monitor. When the carriage return character is typed, the data in the buffer is processed. We have seen that the first four characters are compared to the entries in the command table if they are not lines for the file. But what happens to other characters in the input buffer? Aha! If properly formatted, additional characters show up in certain holding buffers. The proper format is as shown above for the ZERO command, where the command name and each parameter are separated by one or more spaces.

In our ZERO example above, the beginning and ending addresses of the memory block we want to zero will appear in ASCII form in the ABUF holding buffer, and in binary form in the BBUF buffer. We then have our choice of formats in which the parameters may be retrieved. Here's how the example parameters would appear:

ABUF: 41 31 30 30 41 31 46 46
(ASCII hexadecimal codes)

BBUF: 00 A1 FF A1
(binary integer form)

Each group of four digits in ABUF is right justified. If, for example, you entered the first parameter as 27, the first four ABUF characters would be 0027.

To use the parameter passing feature, begin the program with a CALL to the monitor routine VCHK at address 0333/F293. This routine checks the buffer to make sure that you didn't forget to enter a parameter when one is required by a program. If VCHK finds the parameter buffer empty, you'll get a WHAT? and will have to start over and do it right.

VCHK knows whether or not a parameter was entered because all locations in ABUF are initialized to hexadecimal 00. The value you type in replaces the zeroed bytes.

If you get back to your program after your CALL to VCHK, a parameter was entered and you can proceed. If your program requires a second parameter, the following magical incantation may be used to make sure that it, too, was entered:

```
LDA   1082/D05E   ; Get first char of
                    second parameter
ORA   A           ; Set flags
JZ    04A5/F41A   ; Output error mes-
                    sage if no
                    parameter
```

If you don't get a WHAT?, you've got the second parameter.

After determining that you have the required data for your routine, they can be retrieved from the ASCII or binary buffers at the addresses shown in table 2.

Adding your own executive commands to SYS 8 will make it easier and more convenient to run the special programs that are resident in your system; and you won't have to look up or try to remember their starting addresses.■

What's New?

A Hard Copy Gem



Anderson Jacobson Inc, San Jose manufacturer of data communications equipment, recently announced the availability of its AJ 841. Designed for the dual purpose user, the AJ 841 doubles as both a heavy duty IBM Selectric typewriter and an interactive remote computer terminal.

As a terminal, the AJ 841 features 15 cps printout with a 2 character buffer to accommodate burst typing of up to 17 characters per second. EBCD and Correspondence codes are standard for interface with any IBM computer and APL code is also available. A built-in modem and acoustic adaptor may be purchased for easy remote computer access.

For the dual purpose user, the AJ 841 functions as a Selectric typewriter with a 15" (38.1 cm) carriage, interchangeable fonts, typomatic and n-key rollover.

For further details contact Bill Graham, Product Marketing, Anderson Jacobson, 521 Charcot Av, San Jose CA 95131, (408) 263-8520.■

SWTPC 6800 BASIC

Southwest Technical Products Corp has released its copyrighted 4 K and 8 K BASIC software. The 4 K version was demonstrated to us at PC 76 in September. Both feature fixed and floating point math with a full 1.0E-99 to 9.9999999999E+99 number range. In addition to the line number mode a direct (no line number) mode of execution is provided on most statements to create a calculator like mode of entry for short programs. Provisions have been made in both packages for saving and loading BASIC programs to and from either cassette or paper tape. A USER function is even provided for jumping to machine language subroutines.

Both packages have been written for the SWTPC 6800 Computer System. The 4 K BASIC requires a minimum of 6 K of memory with 8 K recommended, while the 8 K BASIC requires a minimum of 8 K of memory with 12 K recommended. The 4 K BASIC tape and manual are attractively priced at $4.95 on "Kansas City" cassette tape and $10 on paper tape. The 8 K BASIC tape and manual sell for $9.95 on "Kansas City" cassette tape and $20 for paper tape. All prices are postpaid in the US. These packages should work on any 6800 computer system which uses Motorola MIKBUG.

SWTPC BASIC SUMMARY

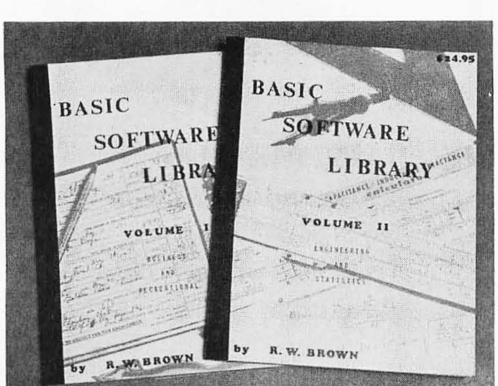
Commands	Statements			Functions		
LIST	REM	END		ABS	†VAL	†SIN
RUN	DIM	GOTO*	STOP	INT	†EXT$	†COS
NEW	DATA	ON. . .GOTO*	GOSUB*	RND	†LEN$	†TAN
SAVE	READ	ON. . .GOSUB*	PATCH*	SGN	†LEFT$	†EXP
LOAD	RESTORE	IF. . .THEN*	RETURN	CHR	†MID$	†LOG
PATCH	LET*	INPUT	†DES	USER	†RIGHT$	†SQR
	FOR	PRINT*	†PEEK	TAB		
		NEXT	†POKE			

** Direct mode statements*
† 8 K Version only

Math Operators		Relational Operators	
-	(unary) Negate	=	Equal
*	Multiplication	<>	Not Equal
/	Division	<	Less Than
+	Addition	>	Greater Than
—	Subtraction	<=	Less Than or Equal
††	Exponent	>=	Greater Than or Equal

Apply Your Computer's BASIC

Software products, by nature, are largely documentation. The latest example of such documentation to cross our desk is this set of two volumes (a third is in preparation) produced by Scientific Research Instruments Co, PO Drawer 2096, Ashland VA 23005. "What is it?" you ask. It is a package totalling 544 pages for the first two volumes, in which you will find nearly 100 complete program listings for a variety of applications. It's a perfect example of what will probably be a commonplace thing within the next few years: a "listings" book sold widely to convey useful software to users of computers.



The photo shows volumes 1 and 2 of a three volume set. Volume 1 contains 20 business applications and personal bookkeeping programs, 16 games and 13 printer output picture programs. Volume 2 contains 23 mathematics and engineering programs, as well as 23 plotting and statistics programs. According to the series table of contents printed in Volume 2, the third volume will contain several long and complex advanced business programming problems including billing and posting of accounts, inventory control, payroll, risk analysis, etc.

All the software in these BASIC Software Library books is written in a subset of BASIC which is defined in an appendix of the second volume in the series. According to the author's introduction, these programs were all entered and run to verify operation. The BASIC machine used was a GE 635 computer. The listings contained in the book are photo offset reproductions of dot matrix printouts.

Who Can Use These Books?

The primary users of these books will be people with access to a fairly powerful BASIC machine, and a knowledge of the special fields covered by the programs. The author of the books makes no attempt to define the terms and concepts of fields covered. Thus you'll have to know what Gaussian Quadrature integration is if you wish to properly employ the 3 K byte program named "Integration 1" found on page 312 in Volume 2. You'll have to know what the terms and concepts are in a resource allocation problem for a business if you wish to successfully employ the program named "Efficient" found on page 39 of Volume 1.

The BASIC language employed by these programs may differ in some details from the BASIC language employed on any given personal computer system, but the adaptation of the programs should be straightforward once the differences are understood. Nearly all the programs in this series of listings could be run on a BASIC language system which has 15 K bytes of memory on top of the requirements for the BASIC interpreter. Many of the programs are small enough to run in from 2 K to 5 K however. These programs will not work in any "Tiny" BASIC implementation since much of the calculation employs features purposely omitted from the definition of "Tiny" BASIC.

These books are available from Scientific Research Instruments Co, PO Drawer 2096, Ashland VA 23005. The price for Volumes 1 and 2 is $24.95 each. The price for Volume 3 is $39.95. The brochure from the company, which accompanied the samples we received, states that machine readable versions of this software will be made available. In machine readable form, a cassette in "Kansas City" standard form will contain 8 selected pro-

Introducing A Remarkable New Microcomputer:

The Astral 2000

You're reading this ad, so you're obviously interested in getting a microcomputer. You're probably also a bit confused by the number of different microcomputer kits around today. So, think about the things you want in a microcomputer. *Ease of assembly, quality power supply, well designed cabinet and interconnect scheme, peripheral and memory options for an expanding system.*

Some Kit!

Although we have called the Astral a "kit", it actually arrives over 70% assembled. The power supply, processor board and RAM board are fully assembled, burned in and tested before shipment.

There is no complicated wiring harness. In fact, there is no front panel wiring harness at all. The front panel plugs directly into the backplane. Additional circuit boards are inserted through the rear of the chassis directly into the backplane.

Complete System

The Astral 2000 is shipped with power supply, cabinet, front panel components, mother board, processor board and one 8K RAM board. The processor is 6800-based and operates in serial and in parallel. Both RS-232 and 20mA current loop are provided by a serial I/O socket on the processor. This processor is shipped with our own 16K monitor ROM and has provisions for "cycle-stealing" DMA. The memory board contains 8K of low power, 500ns static RAM and uses less than 1.5A at 5V.

Lots Of Options

A computer isn't much fun if you can't talk to it. But you can talk to the Astral with the VID-80 video terminal board for only $189.95 unassembled ($245 assembled). The VID-80 has a selectable line length of 64, 72 or 80 characters per line. It displays 16 lines of upper case characters but gives you the option of installing a lower case character ROM as well.

We also have someplace for you to put your programs. Our 8K EPROM board ($59.95) is designed for the 5204 and will allow in-system program storage even during power-down. This board is assembled with all components except the EPROMs, however sockets are provided for the memory chips.

We've solved program loading, too. The I/O tape interface unit ($49.95) plugs into the I/O socket on the processor board and allows programs to be loaded from any inexpensive, non-digital tape deck. But if tape cassette isn't fast or big enough, a floppy disk with an Astral bus-compatible controller will be available for under $1,000 in the last quarter of 1976.

A New And Powerful BASIC

A unique and powerful version of BASIC with features never seen before in an 8K version has been designed especially for the Astral system. Astral BASIC contains all the features of competing BASICs and then some; Astral BASIC is also *very* fast.

With the *User Selectable* Floating Point package, the user chooses the degree of precision from the four choices of 6, 9, 13 or 16 digits. Fewer digits use less memory and is faster, however higher precisions are useful for scientific and mathematic applications.

The Astral BASIC's DO statement is unique; it has never appeared in any other version of BASIC. The DO statement is a simple and flexible way to subroutine without the restrictions of formal subroutines. DOs can be nested, too and — of course — Astral BASIC has all the other standard subroutine procedures as well.

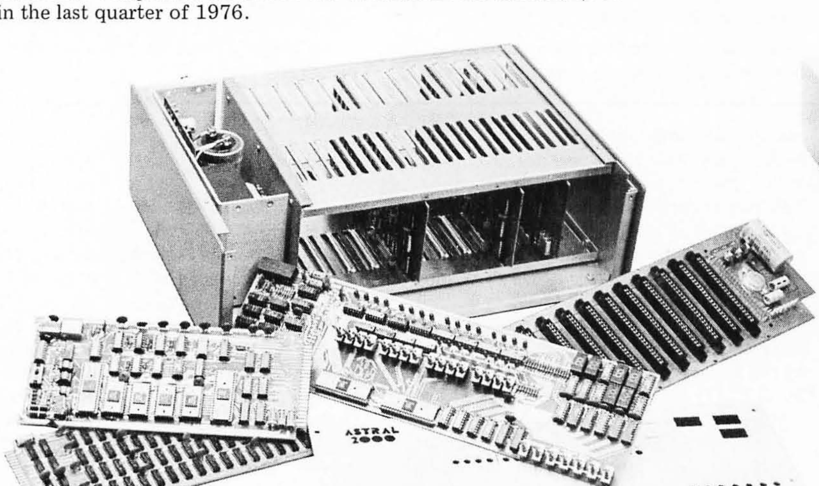
The Trace Mode is another feature rarely found in other BASICs. The Trace Mode is used in program debug to list statement line numbers as executed. This feature may be programmed to Trace On only for routines still needing check-out. Pressing the escape key halts the trace and returns control to the terminal.

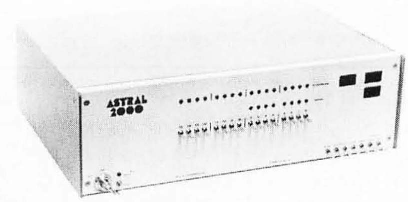
The Astral BASIC string facility permits *variable length strings of unlimited length* and includes the ability to search for a substring within another larger string, a particularly useful feature for word processing applications.

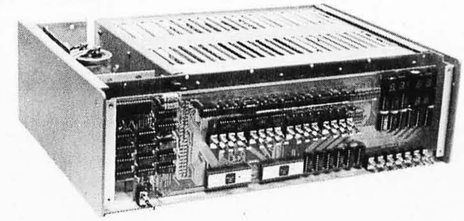
Powerful program editing capabilities allow loading, listing and saving of programs. Blocks of statements may be deleted or renumbered. The RENUMBER statement may be used to increment all specified line numbers and it automatically adjusts the numbering of any GO TOs, etc.

Another feature never seen before in an 8K version is the popular PRINT USING statement. PRINT USING permits floating "$", "+" and "–" signs as well as floating commas, so numbers such as $1,000,000+ can be printed in the standard accounting format.

m&r enterprises
P.O. box 61011, sunnyvale, california 94088







The Astral 2000 is $995 partially assembled ($1250 fully assembled) plus $14 for shipping and handling ($18 for Canadian orders). Additional 8K RAM boards are $245 each. California residents add 6% sales tax. The Software Package includes Astral Basic on magnetic tape cassette or paper tape, the game of Startrek, complete documentation and a free one year subscription to the Astral Newsletter, *all for $35. For more details, send a self-addressed, 8½ by 11 stamped envelope to M&R Enterprises, P.O. Box 61011, Sunnyvale, Ca. 94088. Allow approximately 8 to 12 weeks for delivery.*

grams and sell for $4. In machine readable form, a paper tape with one selected program will run $2. Contact the company for further information.■

A Classy New Microprocessor System



ECD Corporation, 196 Broadway, Cambridge MA 02139, has finally come to market with an advanced graphics oriented personal computer about which we've been hearing vague rumors for a year or so. This photo shows the $987.54 setup as it exists presently: The system components sold by ECD are the keyboard, power supply and computer module stack. The user supplied components of this picture are the television set, shelf, books, cassette recorder, driftwood, rug, panelling, chair, lap, and user, with optional MIT class ring. This system has some novel and useful features which make it one of the better designs presently available on the market.

Gourmet Graphics . . .

This is first and foremost a video graphics oriented processor. What this means is that the machine includes an advanced set of hardware designed to draw pictures on television sets with very high resolution using two different modes of representation. The system can be purchased with an RF modulator option to use a standard television (FCC type acceptance pending), or it can get higher resolution pictures by driving a video monitor directly. The "plain vanilla" version of graphic output supplied with this system is a rather unexciting bit map matrix of 128 by 160 points. This resolution is hardly exceptional, although it is good enough to represent fairly interesting figures using a dot matrix approach. But the "gourmet graphics" aspect of the ECD MicroMind product is found in its character generator. In an unparalleled improvement in flexibility, the ECD engineers have asked, "Who needs a ROM dot matrix?" and answered the question with the use of a programmable memory character generator for high resolution character images. By using a programmable dot matrix character generator memory instead of a ROM, the machine is completely flexible in its generation of the contents of the 8 by 12 dot matrices used for characters. These programmable character patterns provide high resolution regions within the television screen which have an effective matrix of about 500 by 700 dots over the full screen. The character cells are closely packed so detailed images can be carried over between cells when needed. The user gets 128 programmable 12 by 8 dot matrices to work with, which can then be placed in any of the character positions defined on the screen, on command, exactly as if a ROM oriented character were being generated in a conventional display.

What's the user significance of all this? By using a programmable character generator, the ECD MicroMind machine first of all is not limited to any particular character set on its screen. You can display (with proper software) ASCII, APL, Kana Japanese, Greek, Hebrew, Arabic, Cyrillic, chess, music, etc, on this screen! Recognizing this flexibility, the keyboard hardware of the machine comes with changeable key tops which can be custom labelled. But variable character sets form just the start of the flexibility in this system. The fact that the character matrices have no space between characters leads to a high resolution animation games graphics capability.

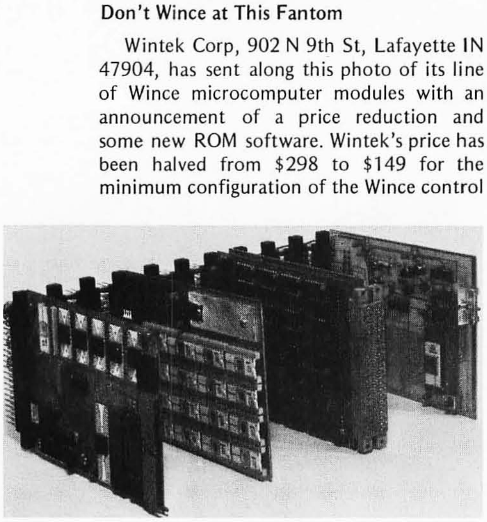
A standard demonstration which is offered with the system is the game ECD calls "Animated Space War." They chose the name because they needed to distinguish it from all the other games around which go by the name "Space War" and are often simply terminal oriented simulations of Star Trek. This game is the ECD MicroMind version of the original space war game which is an MIT tradition since the early 60s. It is played with images of space ships which rotate and move smoothly across what is effectively a high resolution 500 by 700 display matrix — in short, the real thing as far as playing space war goes. If your interest is graphics, it looks as if the ECD product is the ultimate low priced system at this time.

Besides Graphics . . .

There is more to a personal computer than just the display. The functional description of the ECD MicroMind more than meets the qualifications of a genuinely usable personal computer. It comes with the keyboard, power supply and 8 K bytes of memory in its standard form. The system has ROM systems software sufficient to load transient system software from its high speed (400 bytes per second claimed) audio tape recording interface which uses advanced error detection and correction techniques. System software provided as part of your purchase includes (according to the press release) an assembler, a text editor program utilizing cursor editing methods, and an extended BASIC called NotsoBASIC. According to a designer with whom we talked after receiving the press release, NotsoBASIC is an extended version of Dartmouth BASIC which is said to have Dartmouth BASIC as a proper subset. Whizbang software which comes with the system includes the aforementioned Animated Space War game and a version of LIFE. Options include expanding the on board memory of the three card system shown to 16 K by plugging in 16 more 4 K dynamic programmable memory chips, or ordering an optional 32 K memory extension board which can presumably be populated with any multiple of 4 K bytes. If you want a case, you'll have to wait, however. Like a number of recent new products, the initial introduction of the MicroMind is in the form of a factory built set of modules sans case. (A case apparently takes longer to tool up than the electronics which fit inside it.)■

Don't Wince at This Fantom

Wintek Corp, 902 N 9th St, Lafayette IN 47904, has sent along this photo of its line of Wince microcomputer modules with an announcement of a price reduction and some new ROM software. Wintek's price has been halved from $298 to $149 for the minimum configuration of the Wince control



module. This module includes a 6800 processor, clock, data rate generator, 1 K ROM with the new "Fantom-II" monitor, 128 byte programmable memory, an ACIA for serial IO or a PIA for parallel IO. The price of a "maximum configuration module" which includes an ACIA and two PIAs, plus 512 bytes of programmable memory as well as the processor and clocks was also reduced, from $398 to $199. All the modules, as seen in the photo, fit into industry standard 4.5" by 6.5" (11.4 cm by 16.5 cm) printed circuit boards.

The Fantom II monitor according to the release is a 1 K monitor and debugging program that allows single step execution, insertion and deletion of break points, interrupt vector setup, memory loading, examination and changing of memory, printing or punching from memory, display of registers, system reset, and of course, execution of users programs.■

PDP-8 Cross Assemblers for Microprocessors

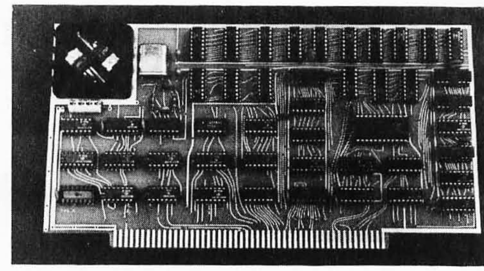
Sierra Digital Systems, 1440 Westfield Av, Reno NV 89509 has announced a series of microprocessor cross assemblers called X8 ("cross-8") designed to allow program development for microprocessors on any PDP-8 with OS/8 operating system software and at least 8 K of memory. According to the press release, X8 assemblers are available immediately for the 6502, 6800 and 8080 processor architectures. Each assembler is priced at $400 and is distributed in PDP-8 binary format on paper tape, DEC tape or DEC floppy disk. Near completion according to the release are assemblers for the 2650 and F8 processors. These products feature a matrix of Universal Assembler Format statements in which the details of each machine are embedded. Options of the assembler include pseudo operations, conditional

assembly, and listing format controls. Arithmetic and logical operators are supported in operand expression evaluation, and output can be specified in Intel BNPF format to run common PROM burners, or in the standard loader formats published for the various processors. A detailed brochure with sample 6502 assembly is available from SDS.■

Want to Turn an S100 Bus Computer into a Number Cruncher? Use This Hardware Floating Point Board

All users of personal computers for number crunching applications around the home, in the lab, or at work in the commercial world will find this new Floating Point Board an attractive option. North Star Computers Inc, POB 4672, Berkeley CA 94704 has designed a hardware floating point processor which enables the microprocessor system to approach or possibly surpass a traditional minicomputer's performance with floating point arithmetic. How's it done? By using the same techniques which the minicomputer would use to implement its floating point: a specialized high speed sub-processor implemented in TTL logic. This specialized processor is shipped a series of data bytes corresponding to the operands of a floating point multiply, divide, add or subtract operation. It is also shipped a command byte. Once it is let loose, it grinds out the answer giving several data bytes of the result operand which can then be accessed by the microprocessor program. The "grinding" process of this little black box of function takes a typical 111 µs for floating multiply with 10 digit operands.

The North Star Computers FPB, Model A, plugs right into an Altair or IMSAI or any other computer with the S100 bus. Its command word sets precision up to 14 decimal digits. A status byte is used to coordinate

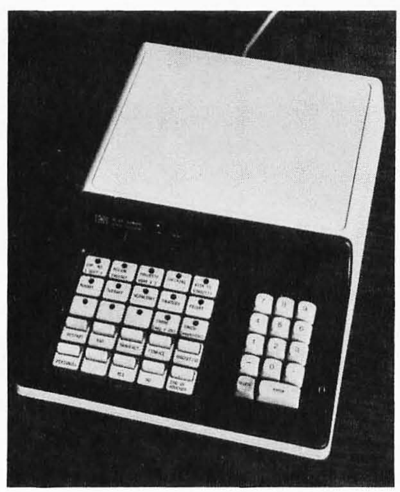


operations and transmit error conditions back to the control processor. An added bonus of this $359 kit product ($499 assembled) is the fact that you can throw out most of the software of your present floating point arithmetic, patching in appropriate FPB drivers in their places. In a typical case, this would free up to a thousand or so bytes of memory which had been required for a floating point software.■

Applications Oriented Computer Terminal

Here is an example of a new product intended for traditional industrial and commercial custom systems markets. The product is the new HP-3070A numeric data entry terminal, which was designed to be used with the new HP 1000 computer system. The interconnection of up to 56 of these new terminals can be accomplished with a single run of twisted pair cables, tapping the cable wherever a terminal is needed, with distances up to 1.24 miles (2 kilometers). It can also act as a satellite to interface remote instrumentation in process control applications.

Of particular note is the layout of the device, shown in the photograph. It is a desk top console unit with a numeric key pad for data, editing keys, 15 indicator lamps and 10 special function key entry switches. The legends shown in this photograph are typed onto a layout form and are protected by a clear sheet of plastic, thus customizing the front panel clearly and very professionally to a particular application system. Here the nature of the captions reflects what looks like a direct labor accounting system for a business situation. The beauty of this particular terminal concept lies in the fact that it is general purpose, since the appli-



cations program determines what the particular keystrokes and display lamps mean in the minicomputer or microcomputer which would monitor the data. To find out more about the HP-3070A Numeric Data Entry Terminal, call or write the Inquiries Manager, Hewlett-Packard Company, 1501 Page Mill Rd, Palo Alto CA 94304.■

An 8080 Subroutine Utility Package

Pragmatic Systems, POB 43, Mountain View CA 94042, recently announced a package of commonly used microcomputer subroutines written in 8080 assembly language. The package, called UT1, contains commonly used code conversions, IO routines for numbers and character strings, and IO drivers for commonly used peripherals. The list of routines we received with this notice had 26 entries spread over 3/4 K of memory. Printed source listings of the program with user documentation are available for $3 each plus $.35 for shipping and handling.■

Paper Tape Holder

Ideal for the hobbyist, this device will hold approximately a 300 foot roll of paper tape as it is being read into the reader. It has been tested on 200 cps readers (also works great on Teletypes). The Paper Tape Holder guides the rolled tape to the reader mechanism free of kinks and twist. It is available in kit form for $8 and assembled for $12. Optional Paper Tape Rewinder is available for $4. Prices include postage and all sales are final. (No CODs.) C V Spinks, POB 9298, College Station TX 77840, (713) 846-6585.■

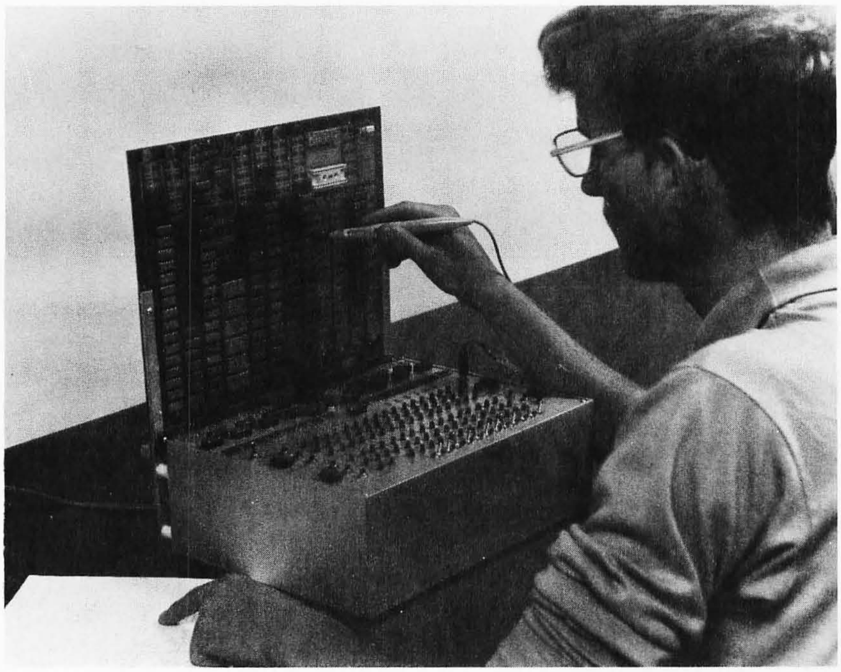
Software New Product: BASIC, ETC

Binary Systems Inc, 634 S Central Expy, Richardson TX 75080, has just introduced a new high level language product for 8080 microcomputer users. The product is the BASIC, ETC interpreter, written by John Arnold and Dick Whipple of Tyler TX. These gentlemen were the authors of the first extant version of Tiny BASIC to be accomplished following publication of the specification in the precursors of the present *Dr Dobb's Journal of Computer Calisthenics and Orthodontia*. (For info on Dr Dobb's write Dr Dobb's, POB 310, Menlo Park CA.) This new interpreter is designed to use the first 8 kilobytes of memory plus at least 1 kilobyte of scratchpad programmable memory on top of that requirement.

Binary Systems Inc is the parent company of the Micro Store in Richardson TX. The firm is marketing BASIC, ETC as a "software kit" which includes the object code of the program (either Kansas City cassette, Digital Group audio cassette, or paper tape formats) and a 32 page user's manual, pictured here. Salient features of BASIC, ETC include: string variables up to 255 characters in length, arrays, variable precision arithmetic, hooks for assembly language routines, character and line editing, nesting of subroutines, formatted output statements, a null statement with delay attributes for 0 to 25 seconds. The price of BASIC, ETC is $25, and the user's manual can be purchased separately for $6.■



A Tutorial Training Computer



Many readers have asked where it is possible to obtain a detailed introductory course in logic and computer design principles. Last June, at NCC, David Winkel stopped by at the booth BYTE shared with Creative Computing and demonstrated the computer resulting from his system, a tutorial project he has been perfecting over the past several years as an engineering educator. As an element of an engineering curriculum, or as a self-study project for a serious amateur, this would be a good starting point for building hardware skills. This product description is supplied by David, whose firm, Logic Design Inc, is located at POB 3991, University Station, Laramie WY 82070. David is a professor at the University of Wyoming, currently on sabbatical leave at the Computer Science Department of Indiana University, Bloomington IN.

The Logic Design system is a method for teaching digital design that has been well proven in a university environment. Recently advanced amateurs have expressed an interest in the system as a way of expanding their skills and knowledge.

The essence of the system is the insistence upon integrating practice with theory. The theory portion is expounded in a new textbook which stresses elegant digital *system* design styles. The design of digital systems is not the same as conventional Boolean algebra although it does use some of the very simple results of that subject. Rather, it is the study of how to take various building blocks such as NAND, NOR gates, MUXs, ALUs, registers, etc, and assemble them into a unified digital system. To illustrate the theory the student builds an elegant original version of the world's most popular minicomputer, the Digital Equipment Corp PDP-8. Because of the clean style used in the design the resulting computer is very simple to understand and debug (there are only 113 ICs in the processor and TTY interface). This tutorial version of the PDP-8 is very fast (330 nanosecond cycle time) and will execute instructions at twice the rate of the commercial version.

While the resulting minicomputer is quite powerful, will run BASIC and costs little more than a corresponding microcomputer system, what we really have to sell is the learning experience of building it.

The package is definitely not suitable for those who regard a computer as a "black box" to be used as a programming tool only. If you are interested in a deep understanding of what goes on inside a computer and are willing to expend the considerable effort required to learn this, read on.

The Logic Design system evolved from 6 years of teaching university courses in digital design and computer architecture. As a result I found:

1. Conventional courses on Boolean algebra alone are not useful. After completion of such a course a student has only the haziest notion of applying this knowledge to digital systems design.
2. There are almost no textbooks on digital systems design.

3. Any "textbook only" course is doomed to failure. It must be coupled with a relevant laboratory in which a real system is built.
4. Most students prefer to build a computer as an example of a real system.
5. There were no suitable commercial laboratory systems available.
6. Each student must build and debug his own system.

As a result I was forced to design my own digital laboratory and write a text to go with it. The assumption was that engineering students would enter the course with no background in electronics or Boolean algebra. The goal was to start from scratch and teach students to design digital systems such as floppy disk controllers, CPUs, tape controllers, etc.

The approach is to discuss the digital design process in the text stressing design style. This is very important since a good style will produce understandable, easy to implement designs. Simple and elegant methods of using good style are introduced. Good designs tend to be so simple that very little Boolean algebra is required in their implementation. What is needed is discussed in the early part of the text. The student gains a solid working knowledge of this by its repeated application in the examples of digital systems. The entire subject is tied together in the laboratory where a minicomputer is constructed and debugged.

To make it possible for each student to build his own computer a powerful breadboard system was developed. All of the messy but necessary items have been prepackaged in the control panel:

1. "student proof" 5 V, 5 A power supply
2. wide range clock
   a. 330 nanosecond – 5 sec
   b. manual push button
3. enough (96) lamp drivers to display every major logic signal. These drivers are Darlingtons so they absorb virtually no power from the logic circuits.
4. 12 electrically debounced pushbuttons
5. 12 toggle switches (expandable to 16)

A general purpose wire wrap backpanel is plugged into the central panel and is used to construct the digital system of interest. This panel is large enough (95 14 pin, 124 16 pin, 10 24 pin and 2 40 pin IC sockets) to construct even very large systems. Connections are made with a hand wire wrap tool using standard 30 gauge wire. The wire wrap pins are replaceable giving the backpanel essentially unlimited life.

One may wonder in this day of the microprocessor why we stress design at a more fundamental level. There are several reasons for this:

1. Interfacing devices to any computer including micros requires digital design at the level we are treating the subject. One need only look at the number of digital interfaces built with integrated circuits in recent issues of BYTE to be convinced of this.
2. There will always be some projects that require more speed than a micro can supply. These designs must be built from integrated circuits using the techniques covered in the Logic Design system.
3. It is jolly good fun.

In summary, what we are offering is a thorough course with one main product and two valuable by-products. The main product is a solid working knowledge of digital systems design. The by-products are a very potent breadboard system for construction of future designs and a very fast powerful 4 K minicomputer.■

8			12
4			0

A

8	9		12
			13
5			
4		1	0

B

8	9	10	12
6	7	11	13
5	3	15	14
4	2	1	0

C

Figure 1: Pattern matching of game situations can be made simpler through the judicious choice of bit assignments. Here is an algorithm for assigning bits of a 16 bit word (numbered 0 to 15) to the squares of a 4 x 4 game board, to facilitate 90° rotations of the pattern by 4 bit circular shift operation. At (a), bits 0, 4, 8, and 12 are assigned by a symmetric progress around the square. Then, bits 1, 5, 9, and 13 are assigned, also retaining a symmetric relationship resulting in a pattern as at (b). Finally, when a similar process of assigning numbers is applied to the remaining bits in a symmetrical fashion, the result is a set of four patterns which interlock in such a way that the four bit shift accomplishes a rotation. This is not a unique assignment; another assignment is shown in figure 2.

Computer Models for Board Games

Russell R Yost Jr
1825 E Palo Verde
Phoenix AZ 85016

A board game situation can be represented in binary code in a variety of ways. Often it will be found that the representation chosen has major consequences in the amount of memory used for program or for the situation memory that seems to be required for most game playing programs. For example, Robert Wier, describing his HEXPAWN program in the November 1975 BYTE (page 36), had plenty of memory available, so chose a representation that was convenient for generating the display and allowed the character codes for X, O, and (space) to be stored for each of the nine squares on the HEXPAWN board. He observed that the game situation memory had to include those cases which were mirror images (reflections) of each other as though they were distinct situations, whereas to the human player, the symmetry makes them completely equivalent. Taking advantage of symmetry and selecting the optimum representation for minimizing memory can often result in substantial decreases in memory space allocations. Similarly, the representation can often be optimized to simplify the program.

I have been thinking about a program for a TACTIX playing machine for several years, and have discovered ways of coding its board situations that reduce memory requirements by close to a factor of 8. TACTIX has been described by Martin Gardner *(The Scientific American Book of Mathematical Puzzles and Diversions*, Simon and Schuster, New York, 1959) as an invention of the Danish mathematician, Piet Hein, a prolific puzzle and game inventor. It is a "take away" game played on a 4 x 4 board. Initially, the board contains one piece on each square. Each player, on his turn, takes one through four pieces from a row or column; but the pieces must be contiguous. The object is to force one's opponent to take the last piece. The game seems to be related to the game of NIM; but, according to Gardner, no algorithm has been discovered for selecting the winning plays, or identifying safe situations as goals for each play. I am planning to implement the game by programming the

computer to build a table of safe situations, by playing two moves ahead and choosing a play that results in a situation that the human cannot turn into a safe situation by any legal move. The problem is, how much memory should be allocated to such a table? Since each square can be empty or occupied, there are 2^{16} possible situations, which would require 131,072 bytes of memory to represent if all were safe. Regardless of how many are indeed safe, it is evident that the memory required could be drastically reduced if advantage could be taken of the equivalence of 90° rotations and reflections of the game board.

In general, eight different 2 byte words represent equivalent situations, and it is possible to choose one of them to represent the whole set. A simple way to select one of the eight is to regard each 2 byte word describing a situation as a double precision unsigned binary number, and select the smallest to represent the set. Thus, to determine if a given situation is included in the safe table, one searches the table for the smallest one of the eight numbers representing the situations equivalent to the given one. Similarly, if a situation has been determined to be safe, its minimized representative number is the one that is stored in the safe table.

Calculating the minimized number is where the assignment of the bit positions of the two bytes to the squares of the 4 x 4 board becomes important. The seven other equivalent numbers are obtained by three 90° rotations, a reflection, and four more 90° rotations. It occurred to me that the rotate type of shift instruction that is implemented in most microprocessors ought to be in some way equivalent to a physical rotation of the board. Four rotations bring the situation back to the starting version; thus, considering that two bytes contain 16 bits, a 4 bit double precision shift ought to be equivalent to a 90° rotation. This leads to the construction of a bit assignment scheme for the 16 squares of the 4 x 4 board as shown in figure 1a. For the moment, consider that a single 16 bit word is involved. Bit 0 can be assigned at random, say in the lower right hand corner. Since a 90° rotation clockwise moves this square to the lower left corner, that square must be assigned to bit 4. Similarly, the other two corner squares, proceeding clockwise, are as signed positions 8 and 12. Now, one may assign bit 1 to any of the remaining squares, which immediately results in the assignment of bits 5, 9, and 13, as in figure 1b. Continuing in this way, the remainder of the bits are assigned as in figure 1c. Note that bits 0 through 3 cover a shape

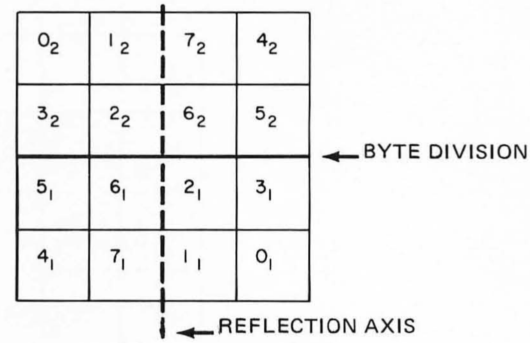


Figure 2: Another operation used in matching equivalent patterns is reflection through an axis. Bit assignments of two bytes to a 4 x 4 game board which satisfy both the 90° rotation requirement and reflection about the horizontal axis is shown in this figure. Each byte independently generates a reflected byte by the algorithm of table 1. For rotations, the 16 bit circular shift operation can be used to link the two bytes together.

Table 1: A Reflection Algorithm for Figure 2. In order to accomplish the reflection through a vertical axis as shown by the dashed line in figure 2, the following correspondences must be programmed.

Each bit in old byte before reflection:	7	6	5	4	3	2	1	0
is moved to	↓	↓	↓	↓	↓	↓	↓	↓
A bit in new byte after reflection:	1	2	3	0	5	6	7	4

This correspondence can be programmed using a series of two bit left circular shifts to position bits, using AND and OR operations to transfer the bits:

		OLD	Value NEW*	TEMP*
Step 1:	Clear NEW value output	76543210	--------	
Step 2:	Rotate OLD left 2	54321076	--------	
Step 3:	TEMP:='00100010' & OLD	54321076	--------	--3---7-
Step 4:	NEW := TEMP;	54321076	--3---7-	
Step 5:	Rotate OLD left 2;	32107654	--3---7-	
Step 6:	TEMP:='01010101' & OLD;	32107654	--3---7-	-2-0-6-4
Step 7:	NEW:=NEW OR TEMP;	32107654	-230-674	
Step 8:	Rotate OLD left 2;	10765432	-230-674	
Step 9:	TEMP:='10001000' & OLD	10765432	-230-674	1---5---
Step 10:	NEW:=NEW OR TEMP;	10765432	12305674	

***NOTE: The numbers in these examples represent values of the corresponding bit in the original source. The dashes in NEW and TEMP indicate bit positions which have 0 value. NEW must be cleared prior to adding new values with the OR operation.**

0_3	1_3	2_3	6_4	7_4	0_4
7_3	4_3	3_3	5_4	4_4	1_4
6_3	5_3	2_5	4_5	3_4	2_4
2_2	3_2	0_5	6_5	5_1	6_1
1_2	4_2	5_2	3_1	4_1	7_1
0_2	7_2	6_2	2_1	1_1	0_1

Figure 3: Bit assignments of five bytes to a 6 x 6 game board to facilitate 90° rotations by whole byte manipulations, and reflections about a diagonal axis by consistent rules for each byte plus the swapping of two bytes.

0_3	1_3	2_3	5_4	0_4
5_3	4_3	3_3	4_4	1_4
2_2	3_2	6_3 6_4 6_2 6_1	3_4	2_4
1_2	4_2	3_1	4_1	5_1
0_2	5_2	2_1	1_1	0_1

Figure 4: Bit assignments of four bytes to a 5 x 5 game board. 90° rotations by whole byte manipulations are facilitated, but reflection rules are complex. A better 5 x 5 compromise is found in figure 5.

that by four successive rotations about the center of the board covers the whole board. Since bits 0 through 3 were chosen arbitrarily, many such patterns can be constructed.

I have not been able to find such a bit assignment scheme that facilitates both the reflecting and rotation. Accordingly, since there are many more rotations than reflections, I have optimized the arrangement for rotation. For simplifying the reflecting, I have selected the arrangement of figure 2 in which one byte represents each half of the board. (In figure 4 and subsequent figures, bits are denoted by numbers 0 to 7, and the byte is designated by a subscript.)

Thus, a single subroutine can be used twice to reflect each byte about a vertical axis. Any axis would serve for reflection, but in this case the vertical axis avoids the need for transferring bits from one byte to the other. Table 1 shows the bit correspondence under this reflection. This is a fairly complicated transformation compared to the simple shift operation needed for 90° rotation. Should the utmost in program speed be needed, a hardware approach along the lines suggested by James Luscher in "Taking Memory Address Space," page 60, January 1976 BYTE, could be used.

The general principles described above for TACTIX 4 x 4 can be applied to other board sizes as well, but as more bytes become necessary to represent the larger boards, rotation representation by whole byte shifting becomes attractive. Figure 3 shows an arrangement for the bits of the five bytes needed for a 6 x 6 board.

Four bytes represent all the squares except the central four, which are represented by four of the bits of byte 5. For a 90° rotation, the first four bytes are shifted, 1 replacing 2, 2 to 3, 3 to 4, and 4 to 1, while the fifth byte is shifted two places. For this case, reflecting about a diagonal, such as the one running from lower left to upper right, is

0_2	1_2	6_3	7_2	4_2
3_2	2_2	7_3	6_2	5_2
4_3	5_3	0_4	1_3	0_3
5_1	6_1	3_3	2_1	3_1
4_1	7_1	2_3	1_1	0_1

Figure 5: The bits of four bytes can be assigned to a 5 x 5 game board in this pattern. 90° rotations are accomplished as in the 4 x 4 matrix of figure 4 for bytes 1 and 2 which are in the corner positions; the 90° rotation component of byte 3 is a 2 position circular shift; byte 4 is unchanged under 90° rotation due to its central position. Reflections about a horizontal axis are accomplished without bit exchanges between bytes.

Table 2: Bit interchanges for the reflection of a 6 x 6 game board about the lower left to upper right diagonal, using bit assignments of figure 3. After swapping full bytes 1 and 3, the same internal reorganization is applied to all bytes.

Each bit in the old byte:	7	6	5	4	3	2	1	0
↓ is moved to ↓	↓	↓	↓	↓	↓	↓	↓	↓
A bit in the new byte:	1	2	3	4	5	6	7	0

most convenient. Then the bits of bytes 2, 4, and 5 are rearranged internally, while the bits of bytes 1 and 3 are rearranged and traded. The rearrangement rules are the same for all bytes, as shown in table 2.

When the board has an odd number of squares along each edge, a central square is invariant under rotation and reflection. This is illustrated by figure 4, which shows an arrangement that permits 90° rotation by whole byte exchanges.

However, reflecting is complex, requiring the bits of each byte to be assigned to two other bytes.

This is avoided in the arrangement of figure 5. Here, 90° rotation is accomplished by double precision shifting of the first two bytes the same as for the 4 x 4 board arrangement of figure 2. The third byte is circularly shifted by two places for 90° rotation, while the fourth byte, containing a single significant bit, is left unaltered.

Reflecting this pattern is simplest about a vertical axis, which avoids bit exchanges between bytes. The rules are the same for bytes 1 and 2, but differ for byte 3, while byte 4 is again unaltered.

Returning to HEXPAWN, here only mirror imaging of the board across the vertical center column is meaningful, since the machine always plays black. Since a square can be vacant or occupied by white or black, two bits are required to represent the state of each square. To facilitate the reflection about the vertical axes, one byte can be used for each column, as in figure 6. Reflection then is accomplished merely by interchanging bytes 1 and 3. Thus, the HEXPAWN program would compare the three byte number representing a given situation with the three byte number obtained by reflection, and would search the model table for the smaller one. Having found the model, the indicated response would then be reflected, if reflecting the original situation produced a smaller number. The number of models stored would be nearly halved by this approach.■

0_1 1_1	0_2 1_2	0_3 1_3
2_1 3_1	2_2 3_2	2_3 3_3
4_1 5_1	4_2 5_2	4_3 5_3

Figure 6: Bit assignments for three bytes to the 3 x 3 game board of HEXPAWN. Since the computer always plays black, rotations are not used to produce equivalent patterns. Two bits are assigned to each game board square in this case to allow modelling of three states: black, white or empty. Reflections about the vertical axis of the drawing are accomplished by exchanging bytes 1 and 3 (left and right vertical columns).

The Built-In Logic Tester

Kurt W Christner
Bently Nevada Corp
Box 157
Minden NV 89423

After unsuccessfully attempting to debug a friend's microprocessor system using the only piece of test equipment he had, a VOM, I decided that every system should have a built-in logic tester. A simple circuit with LED indicators would be adequate to troubleshoot most bad components, open circuits, and short circuits. The logic tester, permanently mounted in the chassis or on one of the printed circuit boards and powered by the computer's +5 V power supply, would always be there to make quick checks.

One simple and inexpensive logic tester that is ideal for building into your system provides indications of TTL logic levels and changes in logic levels. A "Level" LED illuminates for a TTL 1 input and extinguishes for a TTL 0 input. An "Edge" LED illuminates momentarily when the input changes from 1 to 0 or from 0 to 1. Although not as fancy as some of the logic testers described by Alex Burr in the December 1975 issue of BYTE *[page 20]*, this tester provides enough information to detect levels, steps, single pulses, and pulse trains. A more sophisticated tester could also be designed and built into your system if more extensive troubleshooting capability is desired.

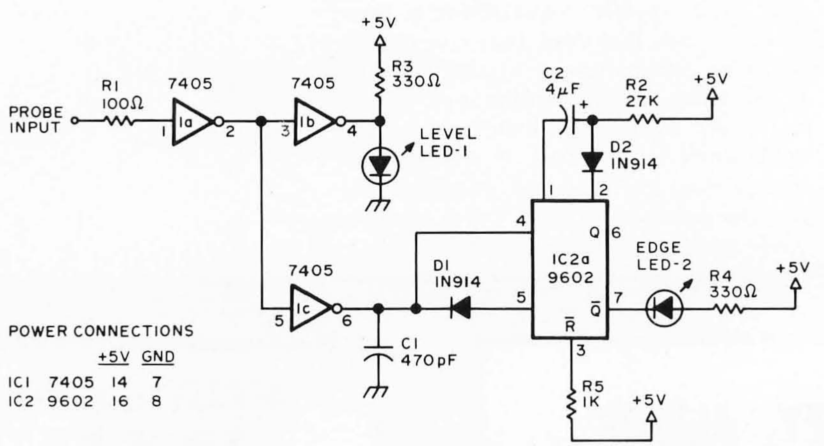


Figure 1: Circuit Diagram of the Built-In Logic tester. Put a logic tester into your system as a permanent section, and you'll never have to hunt for a probe again. The design here could easily be built using integrated circuit sections left over from other uses in a typical computer.

Table 1: Operation of the Built-In Logic Tester. This table lists several input conditions and corresponding outputs of the tester. By looking at both the Level and Edge detection LEDs, the state of the input waveform can be deduced.

Input	Level Indicator LED-1	Edge Indicator LED-2
TTL 0 Level	Off	Off
TTL 1 Level	On	Off
0 to 1 Step	Off then On	1 flash on edge
1 to 0 Step	On then Off	1 flash on edge
Positive Pulse	Off*	1 flash
Negative Pulse	On*	1 flash
Positive Pulse Train	Off to dim*	On
Square Wave	About 1/2 brightness	On
Negative Pulse Train	Brighter to On*	On

***Depending upon duty cycle or pulse width**

Construction

The logic tester described here can be assembled on a small perforated board or a printed circuit board and mounted in an empty space in the chassis, or the tester can be built right on one of the microprocessor boards if there is some unused area. Figure 1 is the schematic of the logic tester. The total price for all parts will probably run less than $4. The circuit uses half of each of two integrated circuits, so a dual tester can be made, if desired. Parts layout is not critical, but observe the polarity of the LEDs, the diodes, and the electrolytic capacitor. The LED indicators should be labeled and positioned so that they can be easily observed and interpreted. A binding post or a screw terminal can be used for the input connection if you want the probe and test lead removable, or the test lead can be soldered to the input if you want it to always be there. Mount the tester in the chassis and connect the +5 V and ground inputs to the system power supply outputs.

Using the Built-In Logic Tester

Apply power to the system. The Level indicator, LED-1, should be on when the input is open or the probe is at a TTL 1. The Level indicator should be off when the

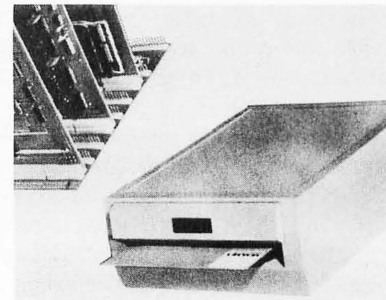
probe is at ground or a TTL 0. Carefully touch the probe to ground, avoiding any contact bounce. The Edge indicator, LED-2, should flash on momentarily and then go off. Now, carefully remove the probe from ground, avoiding any contact bounce. The Edge indicator should again flash on momentarily and then go off. Repeat this several times to verify that the edge detector always triggers on both the positive going and the negative going edges. If it does not trigger on both edges, increase the value of C1 by several hundred pF. This should make the detector trigger on both edges, although it will decrease the maximum operating frequency of the edge detector.

Table 1 shows the operation of the Level and Edge indicators for various inputs. Using this information, you can determine what type of signal the probe is observing by what the indicators are doing.

Theory of Operation

The two open collector inverters, IC1a and IC1b, form a non-inverting driver for the Level indicator. The tester has a fan-in of one TTL load. R1 provides some protection for the input of IC1a. A TTL 0 at the input turns on the output open collector transistor of IC1b. This transistor shunts the current from R3 around the Level LED, keeping it off. The transistor turns off when the input observes a TTL 1, and the current from R3 flows through the Level LED, illuminating the indicator. IC1c is a buffer for the edge detector oneshot, IC2a. The 9602 oneshot works best in this circuit, although a 9601 will work with degraded performance. C1 and D1 are used to trigger the oneshot on both the positive going and the negative going edges. C1 slows the edges going to the inputs of IC2a. D1 provides some offset voltage between the two inputs of the oneshot, so that pin 4 approaches 0 before pin 5 leaves 1 on a negative going edge. This triggers the detector on the negative going edge. For a positive going edge input to IC2a, pin 5 approaches 1 before pin 4 leaves 0, which triggers the detector on the positive going edge. C2 and R2 set the time constant which controls the pulse width of the Edge indicator flash. The Q output of IC2a is normally high; thus the Edge $\overline{\text{LED}}$ is off. When the detector triggers, the $\overline{Q}$ output goes low, turning the Edge $\overline{\text{LED}}$ on. After the oneshot times out, the $\overline{Q}$ output goes high again, turning the LED off until the next edge is detected. The oneshot is retriggerable, so a pulse train input with a period less than the pulse width of the flash will keep the Edge indicator on. D2 protects C2 from reverse polarity conditions.■

What's New?



The $600 Floppy Disk

Ohio Scientific Instruments, by way of the Barefoot Computer Company Information Service, has sent word of their entry into the home computer mass storage marketplace. This is a $599 fully assembled floppy disk drive with read and write electronics, manuals, mating connectors, system interface board (less integrated circuits and parts) and 6502 or 6800 disk operating system. OSI says that it has achieved the low price by using the microprocessor itself as the major component of the disk controller and interface, and supplying basically the mechanism and the critical electronics of the drive itself. The user must supply additional parts estimated at a typical cost of $145 and approximately 8 to 10 evenings of assembly time. These additional parts include the disk's power supply, an enclosure, and cables.

The OSI 470 Floppy Disk and Modem board, which occupies one slot in the company's system backplane, can control up to four disk drives. It also can be configured to provide a 600 baud modem with full dial up and automatic answer capabilities.

With the OSI interface, all tasks that can be handled by software are, thus making it format independent so that the system can read or write virtually any diskette format including the popular IBM 3740 format. Of course, appropriate software must be used for each format.

Double density recording can be used, but system clocks greater than 1 MHz are required unless a very simple disk format is utilized.

The Model 470 comes with a simple and compact 6502 or 6800 operating system. The purchaser must specify which he wants.

The operating system allows the transfer of 4 K blocks of memory to and from the floppy's 77 tracks. To perform a write operation, the user specifies the starting address of the source block and track number. For a read operation, he/she simply specifies track number and starting address of the destination block.

Memory is transferred in 8 bit segments, with 1 parity bit and 1 stop bit. Software automatically performs a write, read, then verify test when writing and parity tests when reading. The software will attempt to write three times before labeling a track unsafe and will attempt to read a track a user specified number of times to recover data.

More sophisticated operating systems are being written for the 470, but this simplest one should allow the user to get his floppy up and running with minimum difficulty, using a small amount of memory and slow clocking.

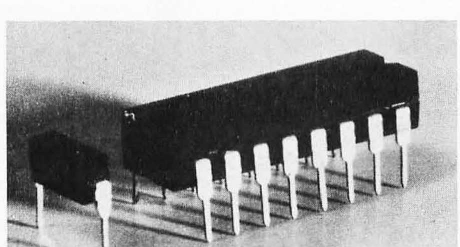
OSI says its low price for diskette drive, manuals and connectors means slim profits and therefore orders must be in writing – prepaid via check, Master Charge or Bank Americard – or via 20 per cent deposit for COD shipment. Purchase orders are not accepted. There is a 20 per cent restocking charge for cancellation of order unless delivery is delayed beyond 120 days after receipt of order.

Drives are manufacturer guaranteed against defective workmanship for 90 days by General Systems International. Although the OSI interface is delivered with the GSI Model 105, it is compatible with the GSI 50 and 110 drives. OSI's $535 price is considerably less than GSI's 50 piece industrial price.

Ohio Scientific is located at 11679 Hayden St, Hiram OH 44234. Barefoot Computer Company is exclusive West Coast distributor for OSI, and is located at POB 158, San Luis Rey CA 92068.■

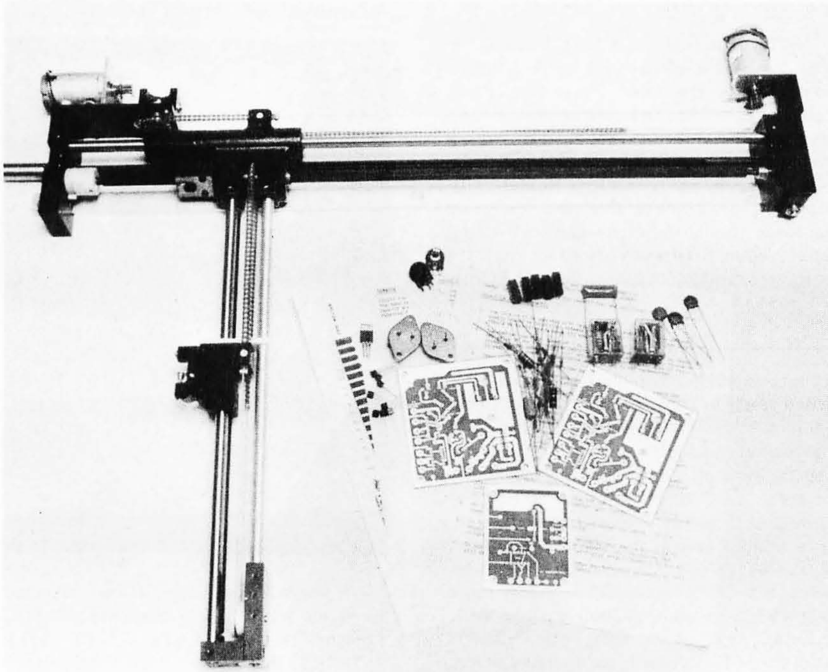
Watch for These in the Parts Markets

We got a press release for a new line of Dual In Line Package capacitors manufactured by AVX Ceramics, Myrtle Beach SC. It makes a nice neat way of mounting capacitors (within available values not listed in the press release) and should appear sooner or later in experimenters' parts markets.■



A "Super" Star Trek game in BASIC...

David Mitchell, a BYTE reader with an Altair system, announced in a letter that he is selling the software of his version of Super Star Trek. This version has the features of Super Star Trek as found in *The Best of Creative Computing, Volume 1*, but he says it is optimized and modified to fit an Altair 8800 with 16 K of memory (including the MITS 8 K BASIC as part of the memory requirement). It should run with other BASIC systems after appropriate modifications of course. His letter says that he has a 15 page description of the game, giving program variables and routines, available along with a listing for $3. He'll also duplicate the program on MITS compatible cassette tape for $6 using Maxwell UD tape. Write David at 2S624 Mulberry Ct, Warrenville IL 60555.■



It's All a Plot to Enable You to Draw with Your Computer

Here is one of the most exciting new peripherals for the enthusiast yet to come down the road. This photograph shows the new Model DFT-1 Plotter Kit manufactured by Sylvanhills Laboratory Inc, #1 Sylvanway, POB 239, Stafford MO 65757. What this kit supplies is all the mechanical details needed to make precision 11 by 17 inch (28 by 43 cm) plots. And if that isn't big enough, the same firm makes the DFT-2 kit, which can be used to build a plotter which will draw on a 17 by 22 inch (43 by 56 cm) bed. According to the flyer received with this photo, Sylvanhills has been making drafting and plotting machines for school and industry for several years, and has decided to make available the mechanism alone in kit form for the hobbyist. It is up to the purchaser to design a nice flat bed on which to mount the mechanism, but anyone handy with woodworking tools should be able to accomplish such a result. The kits from Sylvanhills include the following essentials:

- XY plotting assembly, assembled and tested, ready to mount on the drawing surface. This includes two 24 VDC permanent magnet motors, two incremental encoder disks for feedback control of position using your computer.
- 2 optoelectronic shaft position sensors which mate with the incremental encoder disks.
- 2 motor control printed circuit boards with all components and assembly instructions.
- 1 pen lift printed circuit board with all components and assembly instructions.
- 1 24 VDC solenoid to raise and lower the pen which is held in a general purpose mount.
- miscellaneous components, schematics, suggested layouts and circuitry.

If you want to make a plotter, it looks like this is the ideal way to do it. You get new equipment, completely documented, and a size that is hard to put down.

You'll have to build the table on which it is mounted, and write the software needed to sense position, and move to position on command, etc. But all this is well within the realm of the microprocessor and Sylvanhills has several users at work already on 8080, 6502 and 2650 software to drive this unit. They promise to make such software available to purchasers of the plotters.

What does it cost? Well, for the small DFT-1 plotter kit, the price is $750. The larger model DFT-2 is priced at $895. A 24 VDC power supply which provides 1 ampere regulated for the motor and drive boards is $24.95 in kit form. When you've decided to do computer art via plotter, this kit will be the place to start. . . . But don't stop at simply moving a pen. Have you ever thought that this mechanism now gives you the means to move a puppet about on a microprocessor controlled puppet stage? Hmmm. . .■

Active Filter Activities. . .

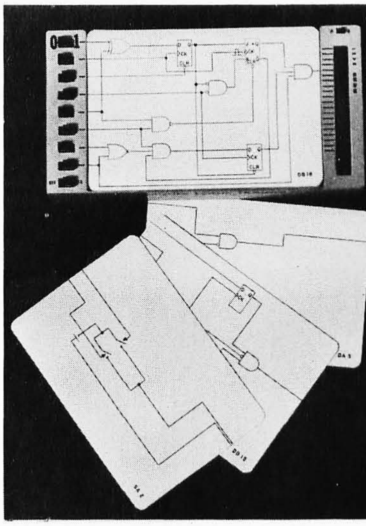
National Semiconductor Corporation has just released a comprehensive series of low cost active filters designed for use with frequencies up to 10 kHz. This was announced to the world in a news release which included the application notes for the AF100 universal active filter line. These circuits are used in analog electronics in systems that include medical, geophysical, sonar, audio, tone signaling, modem and feedback control systems (ie: If you build a robot arm, you may want to incorporate one of these as part of the design for the motion controls.). Optimal use of these filters requires the mathematical and electronics background needed to understand Butterworth, Bessel, Cauer, or Tschebycheff filters. Design equations are given in the applications note

and second order filter parameters can be programmed using only four external resistors. As an experimenter part, however, the AF100 shines, since the commercial plastic packaged DIP version sells for $4.95 in quantities of 100 (a couple of bucks more, probably, if you buy just one, but well within the range of the amateur). For information contact National Semiconductor Corporation, 2900 Semiconductor Dr, Santa Clara CA 95051 and ask for applications information on the AF100, or if you're into electronics, see your nearest National Semiconductor distributor.■

A Pointer

Vector Electronic Co is a fountain of miscellaneous hardware and tools useful in homebrewing electronic equipment. Products of this unique and innovative company range from the new Slit-N-Wrap wiring method (highly recommended) to sockets, matrix boards and enclosures. Readers with interests in breadboarding and designing hardware should definitely get hold of the latest Vector Catalogs. Vector Electronic Co is located at 12460 Gladstone Av, Sylmar CA 91342.■

A Patented Logic Training Computer



A new self paced logic trainer manufactured by L J Broder Enterprises Inc, 3192 Darvany Dr, Dallas TX 75220, (214) 357-7763, has been issued US Patent 3,975,836. The Broder Logic Trainer enables the student to physically manipulate logic states in order to learn logic definitions and solve problems. When the correct solution is achieved a bar appears on the LCD indicator. All basic digital logic components appear in the 40 digital problems which are combinational and sequential. A counter indicates the number of logic state changes made in solving a problem. BCD can be displayed as well as the decimal number. Additional problems can be created to teach specific circuits or even nonrelated subjects. Switching and Venn diagram problems are included. There are no wires or electronic components to misuse or lose.

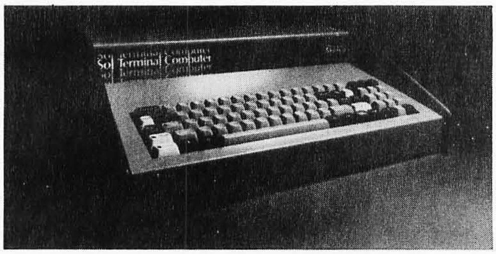
The logic trainer uses a 9 V battery. Expected battery life is one year. There is a one year warranty on parts and labor. Prices range from $59 and $2 postage and handling for single units, to $40 for 500 units and up. Delivery is 12 weeks ARO or better.■

Attention Educators (And Everybody Else Interested in Computers)

Terak Corporation, POB 3078, Scottsdale AZ 85257, has introduced this neat little desk top computing system based upon an LSI-11 and a floppy disk. Unassuming as it looks, this neat little desk top configuration is the Terak 8510 computer system, a stand alone replacement for time shared systems or a superintelligent component of traditional computer networks. This little box contains an LSI-11 microcomputer board, 20,000 words of 16 bit primary memory, a floppy disk drive which can store 256,000 bytes per cartridge, both RS-232C and 20 mA current loop serial interfaces for terminal or Teletype, and software which includes a disk operating system, MACRO Assembler, Editor, Linker, Librarian, Batch Processing, BASIC interpreter and Fortran IV compiler. What does it cost you to get into computing via the Terak product? Including an institutional discount policy, the press release accompanying this picture quotes a "low initial cost, slightly over

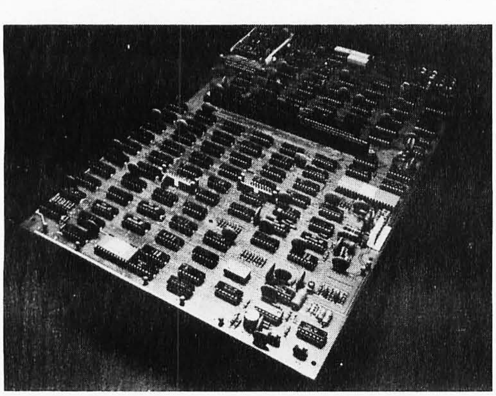
The SOL Source

(a somewhat unusual new product . . . notes by Carl Helmers)



The people at Processor Technology have finally gotten around to sending out nice pretty "press" pictures of their latest, the SOL Terminal Computer. This picture of SOL would be new products news to people reading trade journals and publications to which a broadside mailing of such press releases are obviously intended. However, for us here at BYTE, and our readers, somehow it seems that Bob Marsh and his associates at Processor Technology always seem to get here first with advertisements, long before they get around to writing up the press releases. You first saw this product in BYTE as part of a 6 page advertising spread which Processor Technology ran in the December 1976 issue. So, since the mere insertion of a product picture with words abstracted from the press release would be an exercise in redundancy, a more interesting exercise is to comment on the SOL computer as an illustration of the state of the art in personal computing circa late 1976 and early 1977.

SOL is an example of the complete system concept reduced to a desk top unit with a reasonable price tag. The pretty picture you see here, and elsewhere, is the product concept of the "hassle free" product one expects, a complete computer purchased ready to run. For now, however, you still have to assemble SOL, but the trends in the market guarantee that it'll sooner or later be available completely assembled for the pure "user" types who have no particular interest in putting the device together.

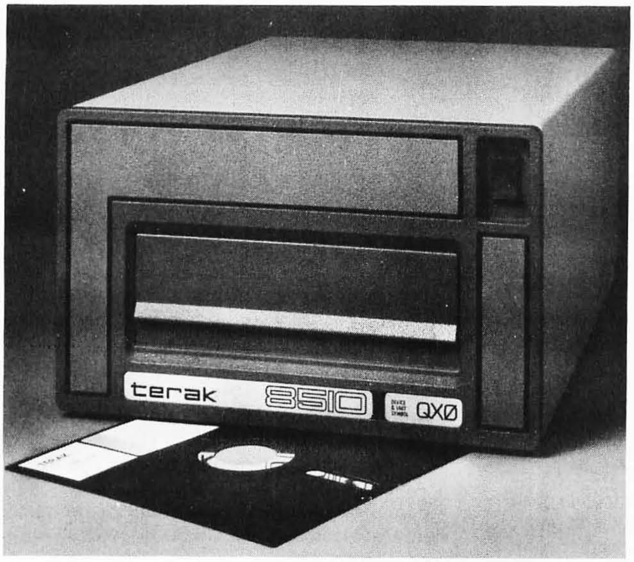


In a talk I gave at the WESCON show in September 1976, I described what might be called the "ideal" computer system circa 1976-1977: an under $2000 package with processor, 8 K of memory, video display output, ASCII keyboard, audio mass storage, ROM systems software and transient systems software. Given this general description, how well does the SOL terminal computer (in kit form) meet the price and performance objectives? A way to find out is to use the published price list of the December advertisements Processor Technology ran in BYTE to specify a tape oriented system . . . the result of this mental exercise is as follows:

Processor, case, power supplies, video display generator, keyboard, minimal programmable memory of 2 K bytes . . . SOL-20 kit	$ 995.00
SOLOS Stand Alone Operating System in place of standard CONSOL	$ 100.00
8K Programmable memory, 8 KRA (for total of 10 K bytes programmable memory in the system)	$ 295.00
Audio tape interface (includes 5 K BASIC)	$ 97.00
Additional transient systems software: assembler, purchased on audio tape	$ 14.50
Applications programs: MATHPAC, TREK 80, GAMEPAK 1 total, purchased on audio tape	$ 33.50
Additonal items not from Processor Technology:	
2 inexpensive cassette recorders	$ 100.00
1 video monitor	$ 150.00
"Benchmark" system total cost	$1785.00

This $1785 expenditure is an excellent example of what contemporary personal computing systems will run in price, where a spectrum of features is chosen to allow programming in a limited 5 K version of BASIC, tape to tape data processing applications, video output and an attractively packaged desk top keyboard product. The only present hitch with the Processor Technology product is that this is still a kit product. But it's available, and it should fill the requirements of many individuals . . .

Delivery is currently quoted at stock to 45 days after receipt of order (ARO). Processor Technology is located at 6200 Hollis St, Emeryville CA 94608.■



$5000." Add an appropriate terminal such as the ADM-3 by Lear-Siegler and you'll have an excellent computer system for use in business or pleasure, for education or for personal computing. No price was quoted for quantity one purchases without the institutional discount. The company is willing to talk to dealers, so who knows . . . maybe this will be the "cadillac" computer model for many an independent store.■

Plasma Displays, Anyone?


APPLICATION NOTE

BULLETIN NO. 5105-1 May 1976

Interfacing Burroughs' SELF-SCAN Panel Displays to Microprocessors.

by Jerry Ogdin, Microcomputer Technique, Reston, Va.

A new six page application note which describes techniques for interfacing microprocessors to alphanumeric displays is now available from the Electronic Components Division of Burroughs Corp.

Written by Jerry Ogdin of Microcomputer Technique, the note provides basic hardware and software instructions for interfacing and for achieving a broad variety of special display effects such as display blinking, letter or word blinking, and display of a wide variety of alphanumeric fonts and special symbols.

For more information contact Electronic Components Division, Burroughs Corp, POB 1226, Plainfield NJ 07061.■

BITS™ Presents:



____TV Typewriter Cookbook by Don Lancaster. A complete guide to low cost television display of alphanumeric data, several chapters of which were published ahead of the book in early issues of BYTE magazine. $9.95

____Digital Logic Circuits by Sol Libes. An invaluable tutorial background volume on digital logic, arithmetic, IO concepts and interfacing to analog devices; written by one of the founders of the Amateur Computer Group of NJ. This book acquaints the reader with much of the terminology and background concepts of digital hardware. $5.98.

____Modern Operational Circuit Design by John L Smith. An absolutely essential introduction to the use and application of operational amplifier systems. The book contains both theoretical background information and practical circuit suggestions which can be used to advantage by the experimenter. $16.95 (hardbound).

____Electronic Projects for Musicians by Craig Anderson. "Even if you know nothing about electronics, you can build preamps, ring modulators, mixers, tone controls, miniampls, fuzzes and a dozen other inexpensive musical projects." Furthermore, even if you couldn't care less about about musical applications, you can use this book to gain familiarity with electronic parts, circuit diagrams and construction techniques, using the wealth of illustrations and tips found in an extended introductory chapter for the novice electronicker. $6.95.

____Active Filter Cookbook by Don Lancaster. The chief chef of electronics Cookbooks concocts another gourmet appetizer. Run to this book when you need to find a starting point for the design of a filter for use in an electronic application. $14.95.

____Altair Design developed by Ensor Holiday.
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____Artist and Computer edited by Ruth Leavit. A visual treat, as you encounter reproductions of numerous works by computer oriented artists and read about these works in their own words. $4.95.

____Linear IC Principles, Experiments, and Projects by Edward M Noll. From basic principles to complicated systems, from simple amplifier experiments to applications in radio, TV and control systems, this book can improve your knowledge of the way circuitry of the analog world really works. $8.95.

____Practical Solid-State Circuit Design by Jerome E Oleksy. A self study course in the design of semiconductor circuits from the simple transistor to the complex operational amplifier. $5.95.

____Boolean Algebra by Brice Ward. A background tutorial and study guide for the design and simplification of static networks of logic gates. Learn how to combine those ANDs, NANDs, NORs and ORs to evaluate complicated logical conditions of multiple inputs, electronically. $5.50.

____Projects in Sight, Sound & Sensation by Mitchell Waite. Dedicated "to all space cowboys." Detailed theory and practice of seven fascinating amateur electronics projects, along with a complete and detailed appendix on how to make PC boards. $4.95.

____Creativity, Invention, & Process by John A Kuecken. Practical philosophy and history for the inventor. $3.50.

____Security Electronics by John E Cunningham. To catch a thief, apply liberal doses of ingenuity and a modicum of cleverness. Find out what's been tried in conventional alarm systems before you go off computerizing your home security system, though. $4.95.

____Introduction to Biomedical Electronics by Edward J Bukstein. What's been done in robot doctors? Nothing so far. But in terms of electronic aids to physicians and practices of health researchers, consult this background review of the field of biomedical electronics. $5.50.

____What to Do After You Hit Return of PCC's First Book of Computer Games. This is PCC's first book of computer games, a compendium which includes descriptions of numerous games, and listings of 37 selected BASIC games. $6.95.

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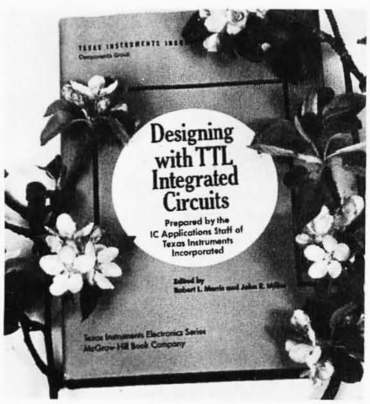
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You may photocopy this page if you wish to leave your BYTE intact. Please allow six weeks for delivery.

A BIT More

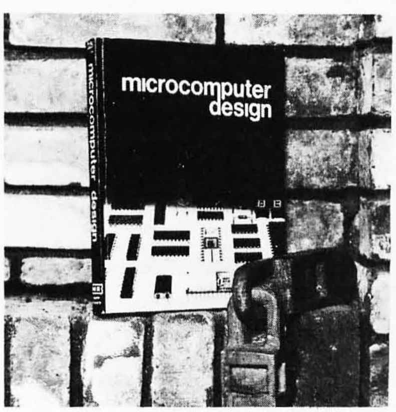
When you build a project, you need information. All you find in the advertisements for parts are mysterious numbers identifying the little beasties . . . hardly the sort of information which can be used to design a custom logic circuit. You can find out about many of the numbers by using the information found in these books. No laboratory bench is complete without an accompanying library shelf filled with references.





Order these absolutely essential references from Texas Instruments today:

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___The Linear and Interface Circuits Data Book for Design Engineers, $3.95.
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___The Transistor and Diode Data Book for Design Engineers, $4.95.
___The Power Semiconductor Handbook for Design Engineers, $3.95.
___Understanding Solid State Electronics, $2.95.
___The Optoelectronics Data Book for Design Engineers, $2.95.
___Designing with TTL Integrated Circuits, edited by Robert L Morris and John R Miller, published by McGraw-Hill, $24.



__**The TTL Cookbook** by Don Lancaster, published by Howard W Sams, Indianapolis. Start your quest for data here with Don's tutorial explanations of what makes a TTL logic design tick. 335 pages, $8.95.

__**Microcomputer Design** by Donald P Martin. Edited and published by Kerry S Berland, Martin Research. Purchase your copy of the definitive source for circuitry and hardware design information on the 8008 and 8080 computers today. Even Intel, the originator of the microprocessor revolution, is hard put to compete with the wealth of information found in Martin Research's new second edition of **Microcomputer Design.** This is the book which was originally published as an expensive (but quite practical) engineering report in loose leaf form, at about the time the microprocessor technology was first catching on in the form of the 8008. This 388 page second edition of the manual is loaded with detailed information on how to build and use computers based on the 8008 and 8080. $25.

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Potpourri from BITS™

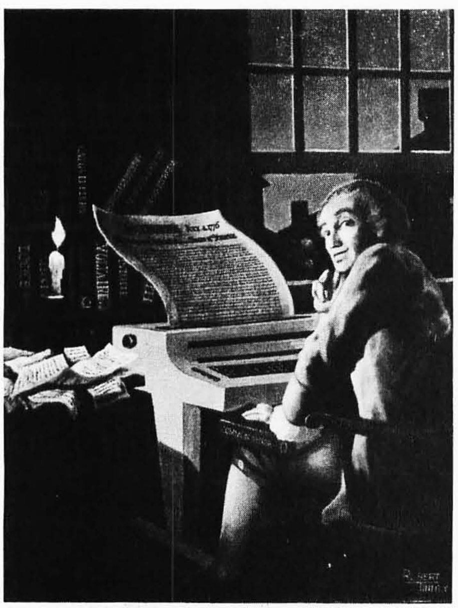
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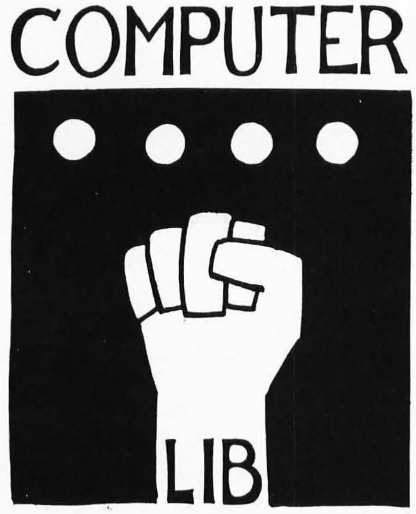
It's Almost Too Late . . .

. . . to snap up bicentennial memorabilia before you have to hunt through the nostalgia shops and pay 100 times the original price—if you're lucky enough to find a bargain—for an item as anachronistic and otherwise remarkable as Robert Tinney's Computing 1776 picture.

A same-size (16 by 20 inches, 41 by 51 cm) reproduction of Tinney's original oil painting, this poster makes an off-beat gift.

Don't wait for the nostalgia shops to get the last of these posters; get yours now for only $2.95. (Do you know what your old Amazing Science Fiction magazines and Superman comics that Mom threw out are worth now?)





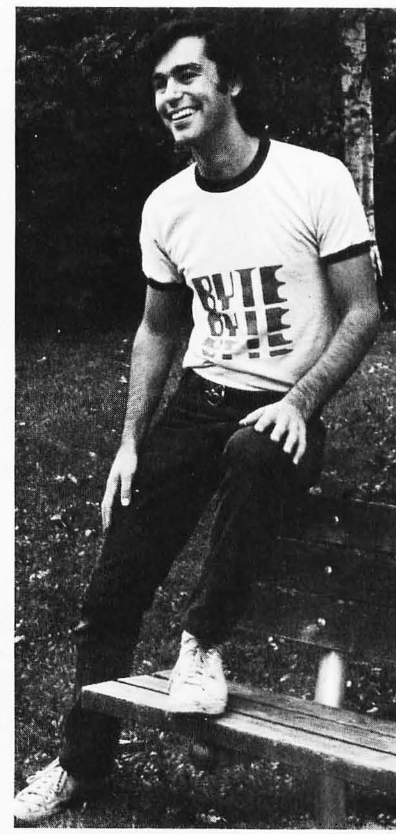
Have you ever wondered where to go for a basic starting point in your quest for information about computer applications and uses? Ted Nelson's book, *Computer Lib/Dream Machines*, is the place for you to begin.

Computer Lib/Dream Machines is for the layman — the person who is intelligent and inquisitive about computers. It is written and self published by a philosopher who is also a self confessed computer fan and an excellent teacher of basic concepts. (For those who have not yet heard, ivory towers are constructed out of real and substantial white bricks.)

Computer Lib/Dream Machines is must reading for the beginner, and is also a refreshing self examination for the old hand at programming and systems work.

BYTE T-shirts

Available in blue heather with blue trim and red letters, or in white with blue trim and red letters. Only $5, including postage and handling.



Please send me:

_____copies of **Computer Lib** @ $7

50 cents postage per copy _______

Total_____________

_____posters @ $2.95

Total_____________

_____T-shirts

_____small _____large

_____medium _____extra large

_____white, blue trim, red letters @ $5

_____blue heather, blue trim, red letters

Total_____________

Grand Total_____________

Send to: **BITS, Inc**
70 Main St
Peterborough NH 03458

Check payment method:
___My check is enclosed
___Bill my MC No. _____________ Exp. date _________
___Bill my BAC No. _____________ Exp. date _________

Name _______________________________

Address _______________________________

City _______________ State _______ Zip _______

Signature _______________________________

You may photocopy this page if you wish to leave your BYTE intact.

Please allow six weeks for delivery.

Build the "Coffee Can Special" EROM Eraser

Lawrence Burbey Jr
2196 Patty Ln
Green Bay WI 54304

If you plan to reprogram your erasable PROMs (EROMs) you have probably noticed a general lack of information on cheap ultraviolet sources to do the job.

EROMs like the 1702, 1702A, 2704 and 2708 are erasable with high intensity ultraviolet light at a frequency of 2537Å. Many clothes dryers manufactured in the 1950s used a germicidal ultraviolet lamp to kill bacteria during the drying process. The lamp produces high intensity ultraviolet at 2537Å and can be purchased as a replacement part for less than $5 from your local appliance service departments.

The ultraviolet lamp was wired in series with a 25 to 40 W 115 VAC lamp to limit current in this application, so that the ultraviolet bulb is not burned out.

WARNING

Shortwave ultraviolet light can harm eyes and skin. Avoid looking into the lamp when it is lit.

A safe way to utilize the germicidal ultraviolet lamp as an EROM eraser is to mount it inside a 2 lb coffee can. The current limiting incandescent lamp can be mounted on the outside, along with an AC toggle switch; in this way the ultraviolet source is not visible while in use and the incandescent lamp can serve as an indicator light — don't lift the can if the light is lit. Figure 1 shows how to arrange things.

The EROM to be erased is placed on a pedestal; its height should allow a one inch clearance between the ultraviolet lamp and the EROM. Erasing time is approximately 10 to 20 minutes. Remember to wire the two lamps in series (figure 1) or you will blow your ultraviolet lamp bulb. A mechanical egg timer with a loud "cling" can be used in conjunction with this unit to time the erasing interval.■

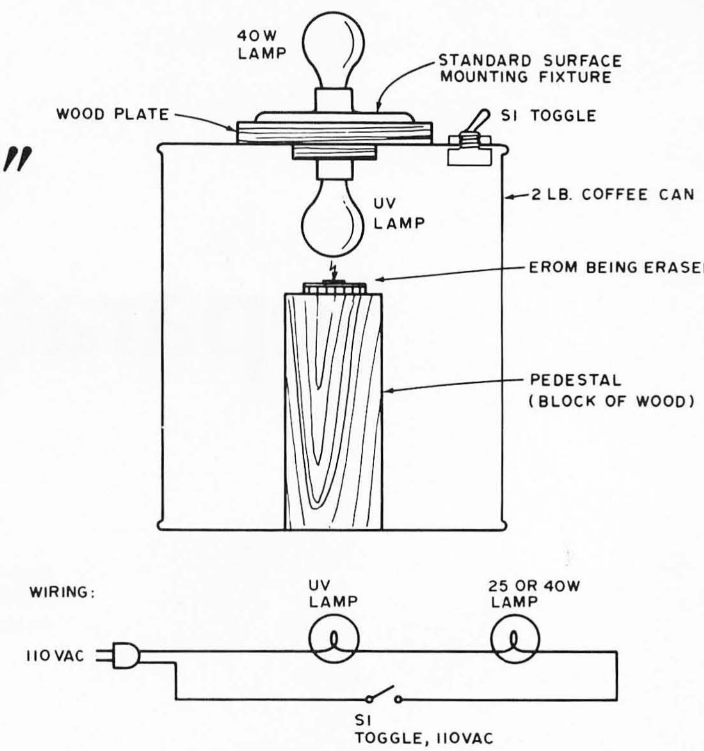


Figure 1: The physical assembly and circuit of the inexpensive EROM erasing apparatus. An ultraviolet bulb available as a replacement part for electric clothes dryers with germicidal cycles provides the source of the ionizing light needed to erase 1702, 2704, 2708 and similar EROM devices.

Separate Your Sync

David Rosen
7 Lillian Rd
Malden MA 02148

While building my television typewriter (from the Southwest Technical Products kit), I searched around the various surplus stores and TV repair shops in my area for a second hand TV receiver to use as a display. Fortunately, I came across a Sylvania model SDM-5035 12 inch video monitor. This monitor was once part of a data processing terminal. It is designed specifically for optimum legibility in the presentation of alphanumeric display information in dot matrix format.

The model I obtained has separate sync amplifiers rather than a sync separator. The advantages of separate sync are twofold; interlacing is improved because cross talk from the sync separator is eliminated, and the computer terminal can be designed more simply because a sync combiner is unnecessary. Of course the TVT design already has a sync combiner. This circuit must be bypassed to use the separate sync amplifiers in the Sylvania display.

The Sylvania vertical and horizontal sync amplifiers are identical. One is shown in figure 1. They require positive going sync pulses compatible with most IC logic. A

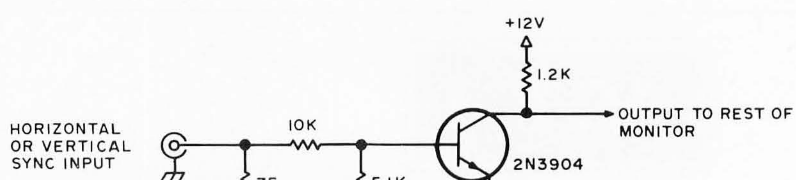


Figure 1: Sync Amplifier Circuit for Sylvania SDM-5035 Video Monitor. The amplifiers for horizontal and vertical sync are identical, and are designed to receive TTL compatible signals. The problem is: How can the separate TTL sync pulses be obtained from the TVT?

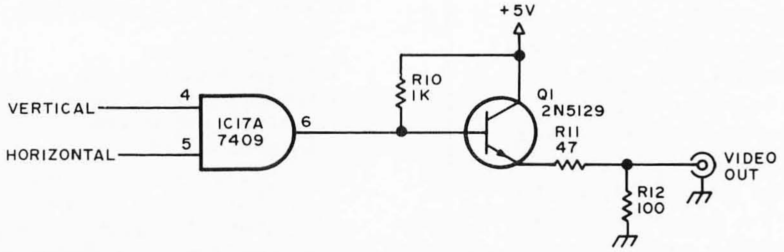


Figure 2: The Southwest Technical Products CT-1024 TVT Sync Combiner Circuit. This is the circuit as it comes in the kit. To apply separate sync to a monitor, simply tap the vertical and horizontal inputs to the sync combiner gate, IC17a.

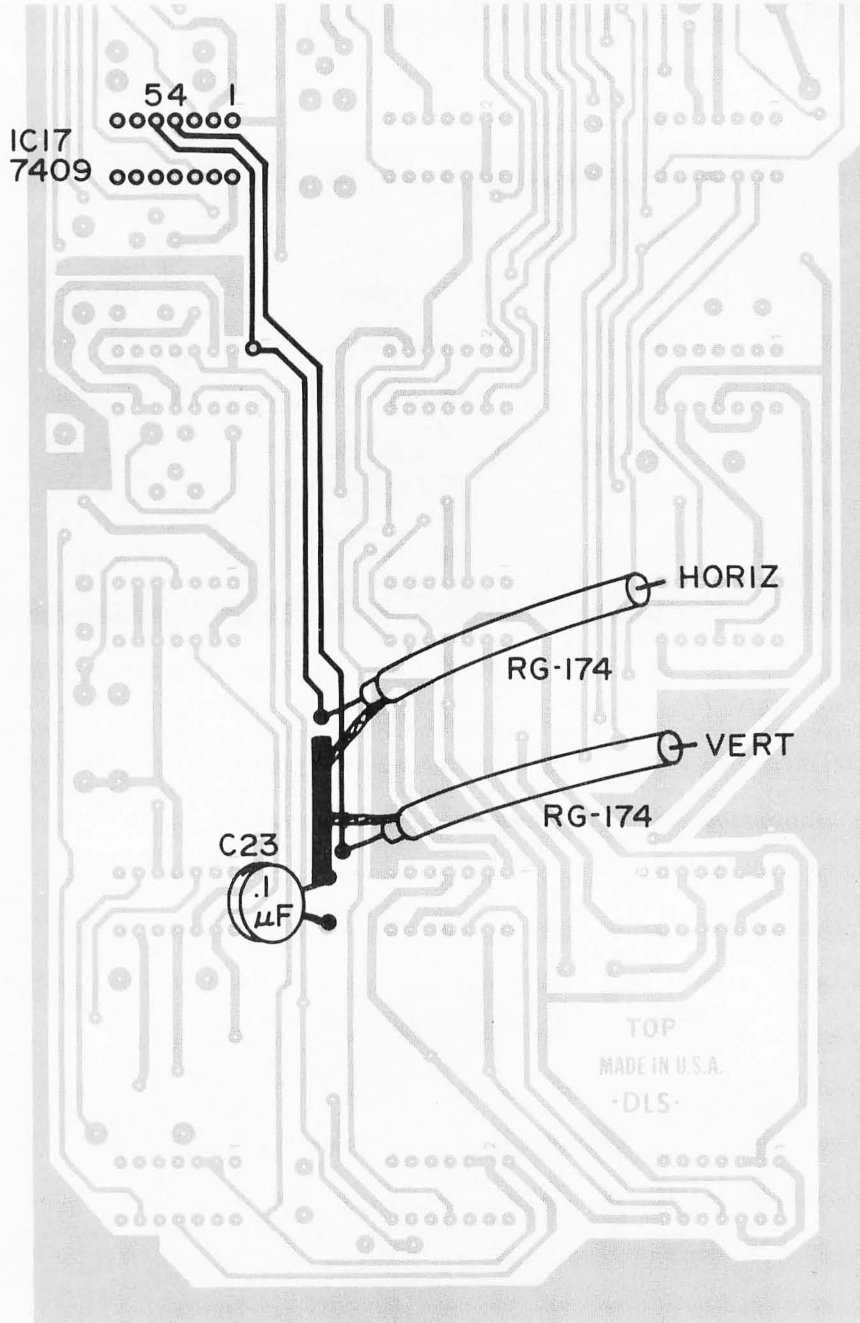


Figure 3: Physical Detail. The modification can be made by tapping the CT-1024 board with RG 174/U miniature coaxial cable, which is run from the TVT to the monitor inputs.

logical zero equals 0 to 0.8 VDC and a logical one equals 2.8 to 5 VDC. These levels are conveniently available in the TVT at the inputs to the 7409 quad AND gate feeding the 2N5129 emitter follower stage that drives the TV receiver or video monitor (see figure 2). In the SWTP kit these are called IC 17a and Q1 respectively. The vertical sync pulses appear at IC17a pin 4, and the horizontal at pin 5.

There is also a convenient spot on the printed circuit card to tap these points (see figure 3). There are two empty plated through holes connected directly to pins 4 and 5 adjacent to a 3/4 inch x 1/8 inch (1.905 x 0.3175 cm) ground plane near C23. This makes it easy to solder lengths of RG-174 coax right to the two empty holes, connecting the shields to the adjacent ground. The coax cable can be terminated in RCA phone plugs and brought out to the display.

With this modification there is no need to alter anything else in the composite video circuitry. The combined sync signals still appearing there don't bother the display unit at all.■

Software Bug of the Month

SOLUTION TO SOFTWARE BUG OF THE MONTH 6

W Douglas Maurer
University Library Room 634
George Washington University
Washington DC 20052

There are two acceptable solutions to this problem. First of all, even a formula which converges, like this one, can have some intermediate values that are much too big for the floating point representation in the given computer. Going over to double precision doesn't help, because double precision only doubles the number of significant digits; it doesn't double the maximum exponent. The second acceptable answer is that even when the intermediate values will fit, if they are much larger than the answer, you can get unacceptable roundoff and truncation error.

This is why sine routine calculations are "normalized" by the formula:

$$\sin (x + 2\pi) = \sin x$$

What Prudence should have done is to replace x by the remainder when x is divided by 2π; that is, by $x - (\text{entier}\ (x/2\pi)) \cdot 2\pi$, where entier(z) is the greatest integer in the real number z.■

Product Description: OSI

Robert Baker wrote this review based upon literature supplied by OSI, a "sleeper" in the personal computing market which has been making some pretty interesting technology.

Robert Baker
15 Windsor Dr
Atco NJ 08004

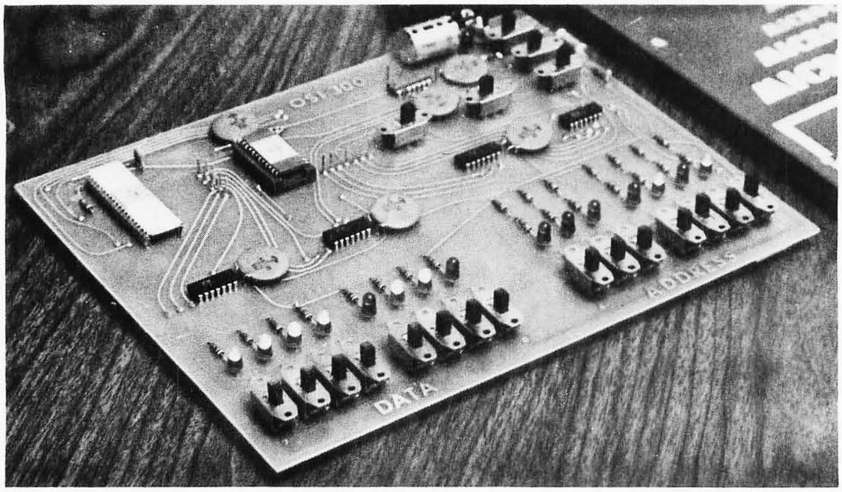


Photo 1: The model 300 computer training board from Ohio Scientific Instruments. This is a one board computer that allows the novice to gain experience using computers before moving on to more advanced models. The 300 model has a memory write protect switch that converts all memory to read only. This protects any stored programs or data. It can be run for 20 hours from four alkaline D cell batteries for total portability.

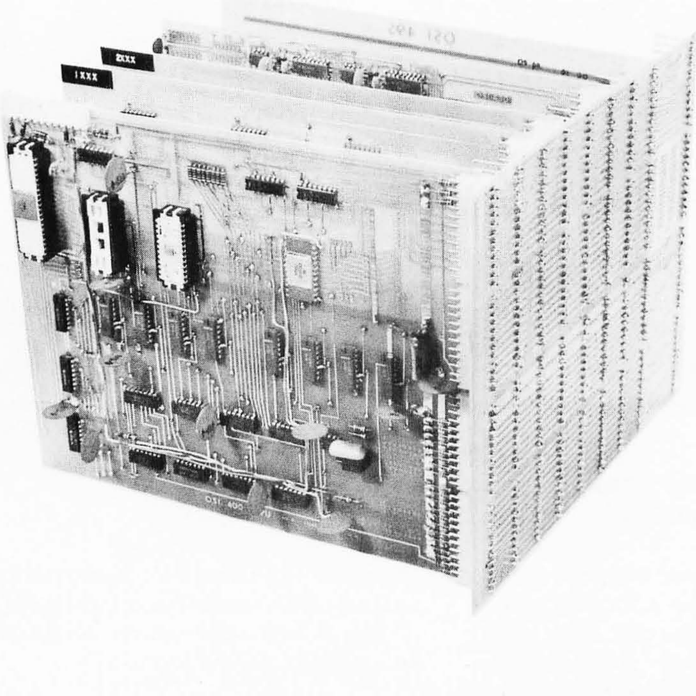


Photo 2: Ohio Scientific Instruments' model 400 Superboard. The Superboard can be based on either a 6501, 6502, or 6800 microprocessor. It contains 1 K of programmable memory, 512 bytes of programmable read only memory, an ACIA with RS232 or 20 mA loop interface, and a peripheral interface adapter with 16 IO lines. The board comes complete with a construction manual that covers the construction and theory of operation.

Ohio Scientific Instruments, OSI, was founded in 1975 by a group of educators and engineers to produce low cost products for education and the hobbyist. In the microprocessor field, their goal is to provide state of the art computer technology in affordable and easy to understand form. Operating overhead is held to a minimum keeping the cost of their kits as low as possible while all parts for their boards are said to be sold at zero profit. However, except for specially preprogrammed read only memories to be used in monitor systems, they sell only parts to populate their own boards.

Newcomers to the microprocessor world will be especially interested in the OSI model 300 computer trainer. The model 300, shown in photo 1, is a single board microcomputer based on the MOS Technology 6502 microprocessor with 128 bytes of memory and a 20 experiment lab manual that assumes no previous knowledge of computers or digital electronics. There are various controls and displays to load and examine memory, a sync line for easy triggering of oscilloscopes, and two input lines and an output latch for IO programming. One nice feature of the trainer is a memory write protect switch that effectively converts all memory to read only memory, protecting any stored programs or data. The 8 by 10 inch (20.3 cm by 25.4 cm) board requires an external 5 VDC, 500 mA supply but will operate for about 20 hours from four alkaline D cell batteries so it can be completely portable.

For small hobby systems, OSI offers their model 400 Superboard, shown in photo 2, which can be based on either a 6501, 6502, or 6800 microprocessor with up to 1024 bytes of programmable memory, 512 bytes of programmable read only memory, an ACIA with RS232 or 20 mA loop interface, and a peripheral interface adapter with 16 IO lines. The Superboard is designed for future expansion utilizing a 48 line system bus common to the 6501, 6502, and 6800 microprocessors. This same bus will locally support the Intersil 6100 12 bit microprocessor as well as the soon to be an-

nounced 16 bit byte at a time processors. The 8 by 10 inch (20.3 by 25.4 cm) double sided G10 board comes complete with a 50 page construction manual that also covers the theory of operation and includes specifications on all components used on the board. Optional, more complete documentation is available for the various microprocessors. Construction is straightforward but troubleshooting may be difficult if a scope is not available. Free advice is available via mail or telephone while a quick turnaround troubleshooting service is available at low cost directly through Ohio Scientific Instruments.

The model 430 Super IO board provides two 8 bit digital to analog converters, an 8 bit tracking analog to digital converter, an 8 bit parallel IO port, and any one of the following serial interfaces:

- Baudot Teletype interface
- 8 level Teletype interface
- Amateur radio frequency shift keying interface
- Audio cassette interface, Kansas City standard

Although designed for use with the model 400 Superboard, the IO board may be used with many other systems including 8008 and 8080 based systems if timing precautions described in the documentation are observed.

Last summer a flier from OSI described their "315 plan" which rents you a computer trainer identical to the model 300 for two months. When you return the trainer you then receive a model 400 Superboard, 430 Super IO board, 440 Super video board, television typewriter and audio cassette monitor software and complete documentation. The plan is designed for the electronics hobbyist with little or no hands on experience with computers. It is said to provide a good understanding of both programming and hardware before actually building a model 400 based system. The three exchange boards provided in the 315 plan form a complete hobby computer system which may later be expanded as desired.

OSI also offers a memory expansion board, a backplane, a prototyping board, and various programmable and nonprogrammable read only memory monitors. Future products will include a video graphics board, a PDP 8 emulator, a floppy disk interface for the GSI model 105 diskette drive, and a basic firmware board for a calculator chip and programmable read only memory with onboard programmer. For a very descriptive flier and complete pricing information, write to Ohio Scientific Instruments, 11679 Hayden St, Hiram OH 44234.■

Classified Ads

FOR SALE: Altair 8800a with 8 K of static memory, ACR cassette interface, 2SIO 20 mA TTY interface, 8 K Altair BASIC (original), and all manuals. This system is fully assembled. The selling price is $1462. If you are interested please call (201) 343-5618 or write Arthur Brussack, 203 Bogert Rd, River Edge NJ 07661.

FOR SALE: Altair 88-4MCD 4 K dynamic RAM memory board. Assembled by experienced kit builder and in good working order. $190 pp within USA. Write or phone Ronald Herman, 13 Simpson Rd, Windham NH 03087. (603) 893-6428.

WANTED: Selectric typewriter/terminal, appreciate info and/or offers to sell. Bill Mitchell, 5805 Farnham Ct, Hanover Park IL 60103.

FOR SALE: Burroughs L-2000 with A-562 paper tape punch and A-581 paper tape reader. Excellent condition. John Crosby, K4GBL, 2506 Devon Dr, Albany GA 31707. (912) 883-4420.

FOR SALE: Bunker Ramo keyboard model 2200 (ASCII) and video display model 2217 combination with self contained power supply, schematics and manuals included, $90. Also model 15 and table $45, 14 TD non sync motor $10, 14 reperf $25. Local sale preferred. John Keslo, 5 Belvina Cir, Pelham NH 03076. (603) 635-2508.

FOR SALE: Creed TTY with interface hardware, $100. Ball 12 inch 10 MHz monitor in cabinet, $125. Two LSI-11 DRV11 parallel cards, $150 each. Jim McCord, 3710 State St, Santa Barbara CA 93105.

FOR SALE OR TRADE: Computer gear, ham gear, Heathkit HW-16, CW transceiver; HG-10B VFO; POLYCOM 62 VHF AM transceiver; WATERS 361 electronic keyer. All in excellent condition. Want to get into hobby computing. Russell Schnapp, 68-07 Main St, Flushing NY 11367. (212) 268-1431.

FOR SALE: MITS very low cost terminal, fully assembled, no case, $85. MITS four slot mother board, used, somewhat beat-up but serviceable, $8. IBM 2311-type disk drive, manufactured by Control Data Corp, 7.5 megabytes of storage for the price of a single floppy disk drive, $850. Will trade for ASR33 teletype, Altair compatible memory, or ?. James R Einolf, 3900 Fos Dr, Loveland CO 80537.

Readers who have equipment, software or other items to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement should be clearly non-commercial, typed double spaced on plain white paper, and include complete name and address information. These notices are free of charge and will be printed one time only on a space available basis. Insertions should be limited to 100 words or less. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.■

WANTED: IBM Selectric I or II & interface for computer. State condition and price. Bill Miller, 1278 Holley Rd, Webster NY 14580. (716) 872-0004, evenings.

WANTED: Western Electric model 804B1 data auxiliary set. Connects to WE 103A data set and looks somewhat like five button telephone. Craig Hjorth, 5122 Canterbury Dr, Cypress CA 90630. (714) 821-1689.

FOR SALE: Two Dura Automatic typewriters, paper tape, edit-control, Selectric printer. Need some repair. One is relay logic, the other is TTL. Has parallel IO ports. Contact Sheldon Linker, World Wide Dictation, 6399 Wilshire Blvd, Los Angeles CA 90048.

WANTED: Will buy or swap — send for list. Disk drive &/or controller, any condition. Floppy disk, any condition. Microprocessor boards, printers, peripherals, working or not. Send description and price to Bob Fallon, 3979 24th St, San Francisco CA 94114. (415) 824-4997.

FOR SALE: IOMEC INC (DIGITRONICS) Model 2540 paper tape reader with factory power supply. Brand new in factory box with copy of manual. Reads 5, 6, 7 or 8 level tapes at 600 char per sec. First certified check or money order for $225 takes it, FOB my address. Also have assorted Teletype equipment and some new very high amperage 5 V power supplies. Robert R McCarthy, 341 Pearson Way NE, Fridley MN 55432.

TRADE: Will trade the first four issues of BYTE — including that elusive #1 — for the May 1976 issue #9 and $5. TSgt John McGaw, 5049 BCSQ Box 669, APO Seattle 98742.

WANTED: I am missing issues 3, 8, and 9 of BYTE magazine. If you have them available for sale, contact me, Joel Walker, POB AE, University AL 35486.

FOR SALE: 1702 PROMs, unused. These require different programming than 1702As. Address must be complemented just before data is applied. 16 PROMs (4 K bytes total) $50, with data. PW Rourke, 30 Garfield Dr, Newport News VA 23602.

FOR SALE: One set of INTEL 3000 series chips, Shottky Bipolar Microcomputer set. Includes 10-3002s, 2-3001, 10-3601 (256x4 PROM), 3212, 3003, 3226, 3214. Lots of documentation, books and data sheets. Completely unused. $250. David Bright, 4809 Broad Brook Dr, Bethesda MD 20014. (301) 530-2890.

WANTED: Operating or maintenance manual for Flexowriter made by Commercial Controls Corp, Model No FPC5P. Will pay for Xerox copy if necessary. Dwight Byfield Jr, 1383 Crespi Dr, Pacifica CA 94044.

CLEANING HOUSE: HP 523 with printer, Ampex TM-4 tape drive with manuals, CES tape drive, new with schematics, Process Tech boards, Altair boards. Large assortment of ICs and other mini and micro parts. Also have cassettes and paper tapes of assorted games for Altair 8800. Send stamp for list. Prices very reasonable. JA MacDonald, POB 5880, Baltimore MD 21208. (301) 484-6382.

INFORMATION WANTED: Anyone who owns a KIM-1 or other 6502 μP, to exchange ideas and information. Write: Gregory F Hogg; 16 Wornom Dr, Seaford VA 23696.

FOR SALE: Complete set of first 12 issues of BYTE magazine, and one copy of the book *Artist and Computer* edited by Ruth Leavitt, together only $35. Send check or money order to Steven Sweeney, 10406 Holbrook Dr, Potomac MD 20854. All letters will be returned unopened after items are sold.

FOR SALE: One set consisting of unpopulated PACE CPU board, memory board, universal wire wrap breadboard, extender board, PACE data book. All boards are high quality professionally made, plated-through with gold edge contacts. Silk screened legends with part placement and value are on all boards. Asking $20 for all. Have extra CPU board for $7. For anyone who makes his own PC boards, I have a couple of real nice card racks that hold 6 cards each and have dual 22 pin edge connectors (wire wrap type), built in card guides for 5-3/4 inch cards of any height, and spacers (feet) for mounting. Asking $10 each. I'll pay postage on above items, money order please. Does anyone have a 8008 data book I could have/borrow/buy? Steve Kelley, 9506 Peach St, Oakland CA 94603.

FOR SALE: Teletype equipment — model 28 ASRs, sprocket feed, $300 up. WU desk faxs. WU model 2bs. Model 14 and 15 parts. Model 28 parts, polar relays, ESUs, perforators, typing reperforators, TDs, etc. GW Hemphill, 132 Scott Swamp Rd, Farmington CT 06032. Phone 6-9 PM only (203) 667-0678.

FOR SALE: Altair 8800 with two 4 K dynamic memory boards, one 1 K static memory board, one audio cassette interface, one 2SIO serial interface and Info Tech terminal, $1400. All boards assembled and working. Philip Higgs, 7714 B-1 Bellstone, St Louis MO 63119. (314) 962-3184.

FOR SALE: Friden Programatic Flexowriter. Model SPS-8, 8 level code printer with ATR auxiliary reader and duplicator. Complete with all accessories. $500. Ken McBride, 2501 Poly Webb Rd #815, Arlington TX 76016. (817) 265-5245.

FOR SALE: Sphere 320 with SIM board (TTY & 2 cassette interfaces), video monitor, 4 K RAM. Assembled, burned in, working. Parts for modem. Immediate Delivery! List about $1875; asking $1600. Richard Tenney, RFD 2, Amherst MA 01002. (413) 323-4555 or (207) 633-2638.

WANTED: May 1976 issue of BYTE. H Cochran, 143 Beaverbrook Rd, Delran NJ 08075.

FOR SALE: ICC/MILGO 4400/48, 4800 baud modems. List price currently is $4800 each. I have two for sale at $800 each, or both for $1500. These modems will operate in full duplex or simplex mode over normal unconditioned telephone lines. They have built-in equalizers and are interfaced through either EIA-RS232 or CCITT-V 24. Also, one ADS-448 data concentrator (four low speed lines to one 4800 baud line), $600. Jim Brick, 820 Sweetbay Dr, Sunnyvale CA 94086. (408) 247-0312.

WANTED: May 1976 issue #9 of BYTE magazine. Please reply with condition and asking price. Pete Bonk, 41A Greenhill Dr, Fishkill NY 12524.

WANTED: PDP 11/XX preferably without memory; BYTE issues #1 to 4 in fair to good condition; TEKTRONIX 465 scope; PDP UNIBUS compatible dual drive floppy disk. Ansel R Dickinson, 3520D Pan American NE, Albuquerque NM 87108.

WANTED: I would like to buy a used or nonfunctional microcomputer and TTY, either homebrew or name brand. Would like price under $150 but send others. Write to: Mike Wixon, 1303 Whitfield Blvd, West Lawn PA 19609.

TRADE: C146A, 826MA, 860H for computer hardware, need not be working. Please contact Dale Hutchinson, 10818 Brentway, Houston TX 77070.

WANTED: Inexpensive ASCII terminals and/or likewise inexpensive computer systems, preferably with documentation. Please give price and condition. Any help appreciated. Contact: Floyd County Computer Enthusiasts, RR #2 Box 466A, New Albany IN 47150.

SWAP: TEC attache case telephone, converts instantly to regular car telephone. Need Altair/IMSAI/POLY 88 mainframe, memory or what-have-you. G Shacter, 9465 Wilshire Blvd, Suite 518, Beverly Hills CA 90202. (213) 274-9834.

BYTE's Bugs

Identification Ambiguities?

I have a "constructive suggestion" to make about your editorial policy concerning articles on construction projects. I feel that all the uncommon ICs used should have a short name given in addition to the manufacturer's type number, and that it wouldn't be a bad idea for all the ICs, especially where the symbol is not a good identification. For example, take a look at page 51 of your May 1976 issue. IC7 and IC9 are quite understandable from their symbols, and types such as "7400" and "555" might be so commonly used as to need no introduction at all, let alone a short name, eg: "quad 2-input NAND" which would have fit in the table at the bottom of the page without taking additional lines. However, the other ICs are not too well known, and the "74265" does seem to be not at all well known. The symbols seem to indicate two ANDs and two buffers each with an additional complementary output in one package. However, I have not found this IC listed in the few sources which I have conveniently available: Lancaster's *TTL Cookbook*, list of TI 7400 series in *Cramer's 1976 Catalog*, and the Motorola reference book on TTL *[See TI Supplement to the TTL Data Book, p. 76]*. Also, unlike the other TTL ICs in this figure, it is not listed for sale in the ad on page 93 of the same issue. *[It should be.]*

Further RS-232C Comments

Re the BYTE's Bug (page 56) on RS-232 levels: I still don't think you have it quite right. An RS-232C (the C refers to the August 1969 version of this EIA standard, which is the most recent revision) driver shall give between −5 and −15 V for a mark and between +5 and +15 V for a space when given a load resistance in the permissible range of 3000 to 7000 ohms. The open circuit voltage is not to exceed 25 V in magnitude (and shall not result in a current of more than 500 mA when shorted to any other conductor in the cable including ground). However, any voltage more negative than −3 V shall be considered a mark and more positive than +3 V a space. Thus, there is a slightly different signal definition depending on whether you are a driver or a receiver. This is of some practical importance because there is a difference between equipment which meets the RS-232C standard and that which is "RS-232C compatible." This latter means that it will work with equipment which meets the standard. But there is no guarantee that two pieces of "RS-232C compatible" equipment will work with each other (although they usually will — with equipment from reputable manufacturers the incompatibility is usually on unimportant details). For example, a driver which swings between plus and minus 4 V will be interpreted correctly by an RS-232C standard receiver and a receiver which makes

101 Basic Computer Games

David H. Ahl. An anthology of games and simulations—from Acey-Deucey to Yahtzee, all in the BASIC language. Contains a complete listing, sample run, plus a descriptive write-up of each game. Our most popular book! Large format, 248 pp. $7.50 [6C]

What to Do After You Hit Return

Another collection of games and simulations—all in BASIC—including number guessing games, word games, hide-and-seek games, pattern games, board games, business and social science simulations and science fiction games. Large format. 158 pp. $6.95 [8A]

Fun & Games with the Computer

Ted Sage. "This book is designed as a text for a one-semester course in computer programming using the BASIC language. The programs used as illustrations and exercises are games rather than mathematical algorithms, in order to make the book appealing and accessible to more students. The text is well written, with many excellent sample programs. Highly recommended." —*The Mathematics Teacher* 351 pp. $5.95 [8B]

Game Playing With the Computer, 2nd Ed.

Donald Spencer. Over 70 games, puzzles, and mathematical recreations for the computer. Over 25 games in BASIC and FORTRAN are included complete with descriptions, flowcharts, and output. Also includes a fascinating account of the history of game-playing machines, right up to today's computer war games. Lots of "how-to" information for applying mathematical concepts to writing your own games. 320 pp. 1976 $14.95 [8S]

BYTE Magazine

If you are considering a personal computing system now or later, BYTE provides a wealth of information on how to get started at an affordable price. Covers theory of computers, practical applications, and of course, lots of how-to build it. Monthly. 1-Year sub'n $12.00 [2A], 3-Years $30.00 [2B]

Games & Puzzles Magazine

The only magazine in the world devoted to games and puzzles of every kind — mathematical, problematical, crosswords, chess, gomoko, checkers, backgammon, wargames, card games, board games, reviews, competitions, and more. Monthly. 1-Year sub'n $12.00 [3A]

Games With The Pocket Calculator

Sivasailam Thiagarajan and Harold Stolovitch. A big step beyond tricks and puzzles with the hand calculator, the two dozen games of chance and strategy in this clever new book involve two or more players in conflict and competition. A single inexpensive four-banger is all you need to play. Large format. 50 pp. $2.00 [8H]

Games, Tricks and Puzzles For A Hand Calculator

Wally Judd. This book is a necessity for anyone who owns or intends to buy a hand calculator, from the most sophisticated (the HP65, for example) to the basic "four banger." 110 pp. $2.95 [8D]

So you've got a personal computer. Now what?

Creative Computing Magazine

So you've got your own computer. Now what? *Creative Computing* is chock full of answers — new computer games with complete listings every issue, TV color graphics, simulations, educational programs, how to catalog your LPs on computer, etc. Also computer stories by Asimov, Pohl, and others; loads of challenging problems and puzzles; in-depth equipment reports on kits, terminals, and calculators; reviews of programming and hobbyist books; outrageous cartoons and much more. *Creative Computing* is *the* software and applications magazine of personal and educational computing. Bi-monthly.
1-year sub'n $8.00 [1A], 3- years $21.00 [1B], sample copy $1.50 [1C]

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Computer Lib/ Dream Machine

Ted Nelson. This book is devoted to the premise that everybody should understand computers. In a blithe manner the author covers interactive systems, terminals, computer languages, data structures, binary patterns, computer architecture, mini-computers, big computers, microprocessors, simulation, military uses of computers, computer companies, and much, much more. Whole earth catalog style and size. A doozy! 127 pp. $7.00 [8P]

Computer Power and Human Reason

Joseph Weizenbaum. In this major new book, a distinguished computer scientist sounds the warning against the dangerous tendency to view computers and humans as merely two different kinds of "thinking machines." Weizenbaum explains exactly how the computer works and how it is being wrongly substituted for human choices. 300 pp. $9.95 [8R]

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Ruth Leavitt, ed. Presents personal statements of 35 internationally-known computer artists coupled with over 160 plates in full color and black & white. Covers video art, optical phenomena, mathematical structures, sculpture, weaving, and more. 132 pp. $4.95 [6D] Cloth cover $10.95 [6E]

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Ted Sage. This text is designed to be used in a one-semester course in computer programming. It teaches BASIC in the context of the traditional high school mathematics curriculum. There are 40 carefully graded problems dealing with many of the more familiar topics of algebra and geometry. Probably the most widely adopted computer text. 244 pp. $5.95 [8J]

A Simplified Guide to Fortran Programming

Daniel McCracken. A thorough first text in Fortran. Covers all basic statements and quickly gets into case studies ranging from simple (printing columns) to challenging (craps games simulation). 278 pp. $8.75 [7F]

Understanding Solid State Electronics

An excellent tutorial introduction to transistor and diode circuitry. Used at the TI Learning Center, this book was written for the person who needs to understand electronics but can't devote years to the study. 242 pp. $2.95 [9A]

Microprocessors

A collection of articles from *Electronics* magazine. The book is in three parts: device technology; designing with microprocessors; and applications. 160 pp. 1975 $13.50 [9J]

Microprocessors: Technology, Architecture and Applications

Daniel R. McGlynn. This introduction to the microprocessor defines and describes the related computer structures and electronic semi-conductor processes. Treats both hardware and software, giving an overview of commercially available microprocessors, and helps the user to determine the best one for him/her. 240 pp. $12.00 [7C]

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its decisions at plus and minus 4½ V will correctly interpret an RS-232C standard driver. However, it is obvious that the nonstandard driver and receiver will not work correctly together. *[I hope this is the last word . . . CH]*

Henry E Schaffer
Professor of Genetics
North Carolina State University
Box 5487
Raleigh NC 27607 ■

A Glitch Pair in Close Orbit

Doug Anderson, of Control Process Corp, 201 Atwater St, Plantsville CT 06479, phoned in a couple of glitches in the copy of Gerald Herd's "A BASIC Star Trek Trainer," which appeared in September BYTE (page 40). The glitches appear at lines 1880 and 1940. At line 1880, the subscript of the matrix variable S is incorrect. That statement should read:

```
1880   LET S(2,J) = 0
```

The second glitch at line 1940 is an assignment operator which was mistakenly printed as a minus sign. Thus statement 1940 should read:

```
1940   LET R = ABS(R)
```

And, Notes on Conversion...

Doug has gotten the program converted to Altair BASIC which he is using for a demonstration "gee whiz" program for Control Process Corp's booths at trade shows. He reports that one of the major differences of the BASIC implemented by Altair relative to the Data General NOVA representation shown in Gerald Herd's article is that the computed GO TO and computed GO SUB syntax differs. Thus if you use the program with Altair BASIC, you'll have to change line 330 to read:

```
330   ON C GOSUB 790,920,1040,1140,
      1180,1250,1310
```

and line 1610 read:

```
1610   ON Z GOTO 1620,1640,1850,
       1730,1730,1780,1780,1780,1830,1830.
```
■

BYTE's Bits

Call For Papers: ICCH/3

We received an announcement of the Third International Conference on Computers in the Humanities, which is cosponsored by the Université de Montréal and the University of Waterloo.

The conference will be held August 2–5, 1977 at the University of Waterloo, Waterloo, Ontario CANADA. Interested parties should send abstracts or papers on any topic regarding computers and their relation to the humanities to Professor Paul Bratley, Departement d'informatique, Université de Montréal, Montréal, Quebec H3T 1J4 CANADA.

The deadline for abstracts or papers is January 15 1977.■

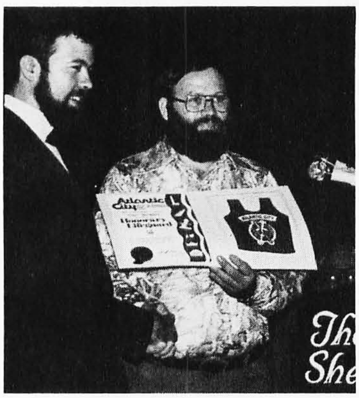


Tom Pittman and friend selling copies of his moderately famous Tiny BASIC for 6800 or 6502 at $5 per copy.



A representative of itty bitty machines expounding on the ins and outs of tiny computers.

Some Candid Shots from Personal Computing 76

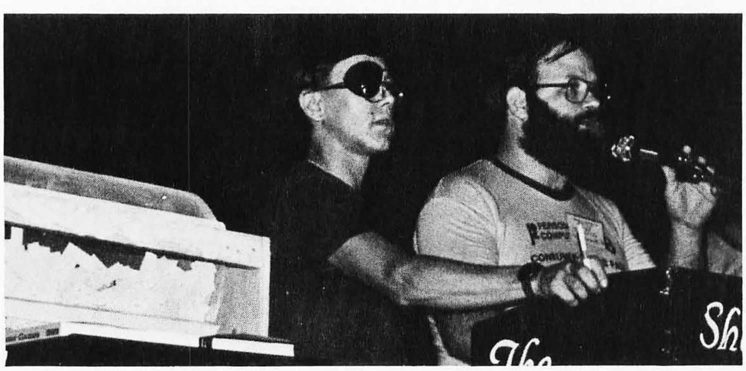


Surprise! BYTE editor Carl Helmers receiving the "award" of an Honorary Lifeguard Certificate, signed by the mayor of Atlantic City, presented by John Dilks, co-chairman of PC 76.

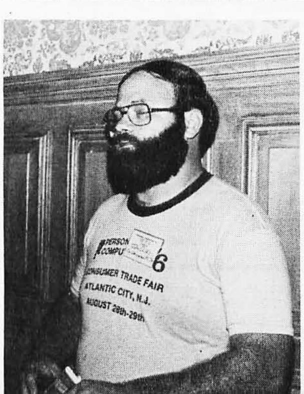
Marj Kirk was circulating around the Personal Computing 76 show in Atlantic City August 27–29, taking candid photos. As noted previously in BYTE, the show was quite a success, and is but a taste of things to come in the area of people and manufacturers gathering for enjoyment, relaxation and exchange of ideas. Future gatherings which we know about at this time include the First West Coast Computer Faire in the San Francisco Convention Center April 15–17, 1977, and the National Computer Conference's special section for personal computing June 13–16. (If your club or regional computer association is planning a big event, be sure to coordinate with us in advance.) These photos, wherever possible, have the people identified.■



Ted Nelson, author of Computer Lib, *a founding father of itty bitty machines (an Evanston IL computer store and idea factory) giving his talk at the banquet on Saturday August 28.*



The Door Prize Drawing. John Dilks introducing the door prize event, with Dave Jones looking on (left). Numerous door prizes, large and small, were awarded, ranging from complete computers to books and other sundries.



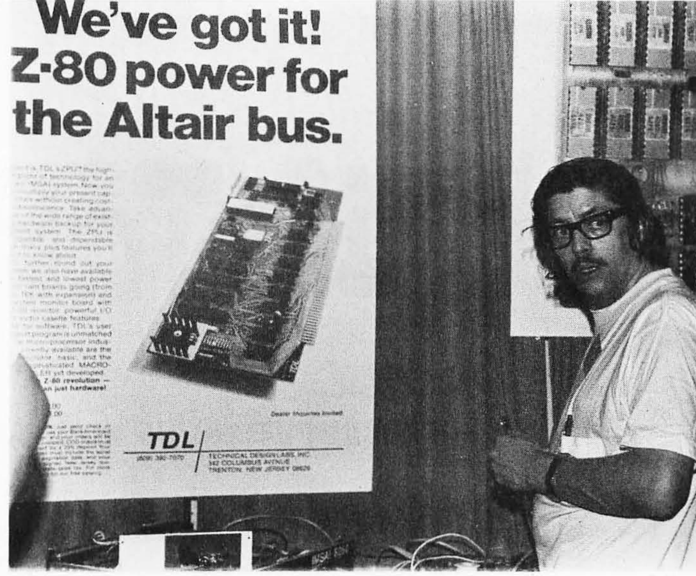
A convention is a lot of work to organize. So much strain and so many sleepless nights caught up with John Dilks, Marj's camera catching him asleep on his feet. . . .

An interesting and human oriented application of computers was demonstrated by Digital Equipment Corp, which set up its LSI-11 model railroad demonstration. Here's a theme dear to the hearts of many home computer people: applying the processor to a hobby.





Tom Kirk (left) of Technical Design Labs and Gordon French of Processor Technology at the cocktail party preceding the banquet.



Roger Amidon, designer of the TDL Z-80 processor board for the S100 bus, shown holding the board which was demonstrated along with Roger's ZAPPLE monitor program.



Robert Suding, designer of the Digital Group Systems and author of several recent BYTE articles, showing off his product. (Note that these photos were taken before the Digital Group's excellent new cabinetwork had been completed. A later appearance of the Digital Group at the WESCON show provided the first public appearance of the unique and professional styling now advertised by the company.)

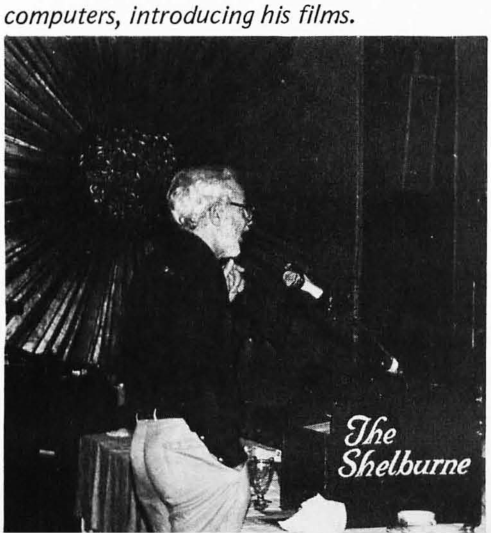


Jan Nilsson, who probably travelled furthest to get to the show, with Steve Kay of Motorola at the cocktail party preceding the banquet. Jan heard about the show when his July BYTE finally got to Sweden one week before it occurred . . . and hopped a jet to the States to see what he could see. A dealer in IMSAI products, he's started what is probably the first retail computer store in Sweden.

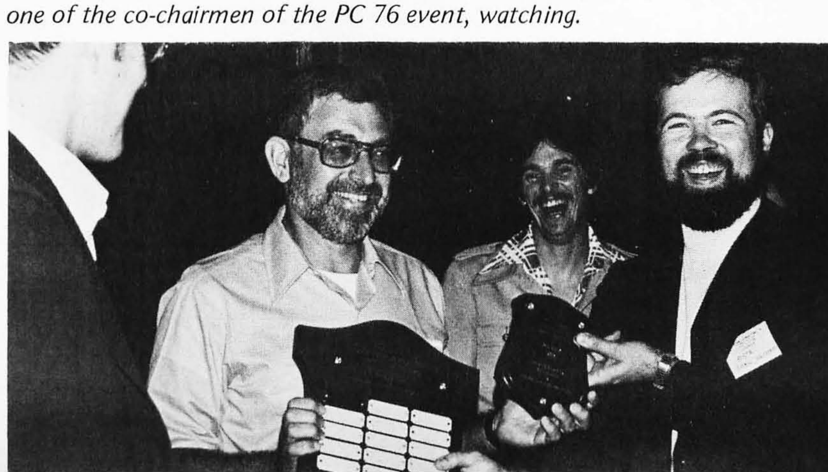


The IBM hospitality suite drew numerous people, who were able to see and use the IBM 5100 personal computer in the form of three demonstration systems.

John Whitney, maker of "Arabesque" and other visual fantasies created with the aid of computers, introducing his films.



Presentation of the "Outstanding Computer Hobbyist of the Year" award to Sol Libes. Carl Helmers made the presentation as master of ceremonies for the banquet, with David Ahl of Creative Computing (left) and James Main, one of the co-chairmen of the PC 76 event, watching.



Continued from page 12

copied into the computer, the programs, written in BASIC, can be used by individual students to deepen their understanding of selected mathematical concepts, or to sharpen their mathematical skills. The programs are of four kinds: tutorial, simulation, data reduction, and demonstration, and are keyed to leading textbooks in secondary school math.

The programs help the student to: Develop the ability to estimate square roots; the values of polynomials; powers of A for various values of A and x; logarithms to various bases; the roots of linear, quadratic and cubic equations; sines, cosines and tangents. Develop the ability to analyze quadratic equations, use trigonometric identities and laws, and factor trinomials. Develop an understanding of parabolas, hyperbolas, circles, ellipses, and other conic sections; higher order polynomial equations and transcendental equations through numerical and graphical analysis; and the concepts of equally-likely, proportions of outcomes, probability, the area/probability and volume/probability relationships, and calculus. Demonstrate that every rational number has a repeating decimal representation. Define π by calculating the circumference of the unit circle and as the area of the unit circle. Use Newton's method to find a real root of higher order polynomials and transcendental equations.

4. Problems for Computer Solution *by Gruenberger and Jaffray, 401 pp, $8.95.*

   A collection of 92 problems for computer solution, many dealing with mathematical topics including evaluating a polynomial, solution of algebraic equations, Hastings approximations, factorials and subfactorials, permutations, Latin squares, prime numbers, chained primes, power residues, primitive roots, calculation of π, etc. There is a lot of *a priori* help, but no completed programs. The authors had FORTRAN, not BASIC, in mind. But it doesn't matter. A classic.

5. Problems for Computer Solution *by Stephen Rogowski, Student's edition, 113 pp, $3.95; Teacher's edition, 279 pp, $9.95.*

   The student edition of this book challenges the student to "write a program to . . ." do 90 different assignments in arithmetic, algebra, geometry, trigonometry, number theory, probability, statistics, calculus and science. There are hints at the

solution and references to texts. The teacher edition contains one or more BASIC programs the author wrote to accomplish each assignment, plus his analysis.

There are also resource books for physics and chemistry:

6. The ENTELEK Computer-Based Physics Lab *by Richard A Rader, 133 pp, 8-1/2 X 11, ISBN 87567-035-0, $14.95.*

   This contains 10 computer programs for use in an introductory physics course. Once loaded into the computer, the programs, written in BASIC, can be used by individual students to expedite the production of tables of data by eliminating the tiresome chore of repeatedly calculating the same physical quantity from multiple measurements. The experiments to which the programs apply are found in numerous physics curricula, including those of Harvard Project Physics and the Physical Science Study Committee. They deal with Snell's law, Kepler's second law, the simple pendulum, speed and acceleration, momentum and kinetic energy, charge of ions, focal length, characteristics of simple electrical circuits, wavelengths of light, mass of the electron, etc.

7. Chemistry with a Computer *by Paul Cauchon, 188 pp, 8-1/2 X 11, $9.95.*

   This book contains 26 computer programs for use in any chemistry course at the high school or college level. The programs, written in BASIC, are of three kinds: tutorial, simulation, and problem-generation. Representative tutorials include exercises with Beer's Law; mass, volume, and density; equilibrium constant; and exponential notation. Simulations include Rutherford's gold foil experiment, qualitative analysis, and the law of heat exchange. Representative problem-generating programs include names and formulas for salts and related acids, and problems on titration and normality, combining volumes and masses of hydrogen and oxygen, etc.

The seven books are divided as to their objective and approach. Three require the student to write a computer program pertaining to some math topic (2, 4, 5). Four list programs which, once loaded into the computer, perform some useful pedagogical task (1, 3, 6, 7). All the above books, plus *Computer Resource Book — Algebra* by Dwyer and Critchfield ($4.20), can be purchased from ENTELEK Computer Books, 42 Pleasant St, Newburyport MA 01950, and, like Professor Bell, we would be interested to hear about any other computer resource books, either in print or in preparation.

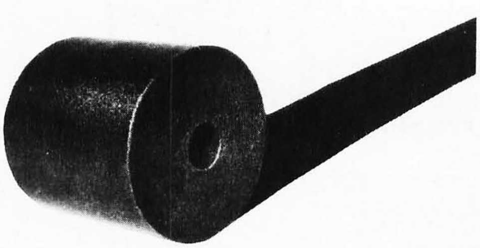
Albert E Hickey
ENTELEK Computer Books■

BYTE's Bits

What Is It, 2

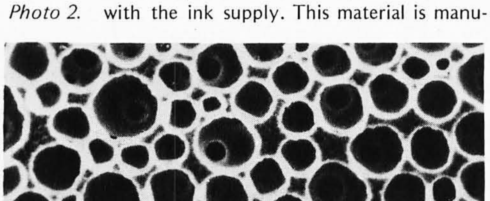
What Is It?

Photo 1. *"An inking device for hard copy impact printers."*

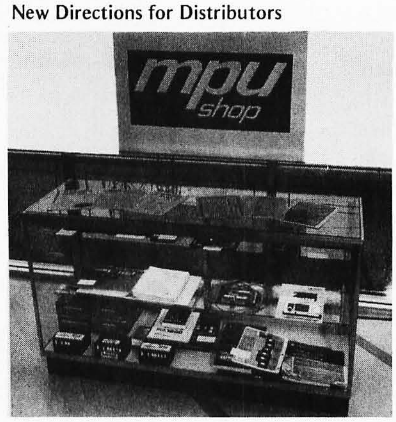


The photograph published last month was a cross section of ink bearing plastic manufactured in the form of the roll shown here. The holes (see photo 2) are designed to meter the flow of ink out to the print mechanism during the life of the ink roll, and the spaces in the foam plastic are filled with the ink supply. This material is manufactured by Porelon Inc, Racine WI, and is sold only to printer manufacturers on an OEM custom basis. But if you see a self-inking printer without a ribbon at your computer store, chances are it uses this technology to put the ink on the print wheel, print drum, etc.■

Photo 2.



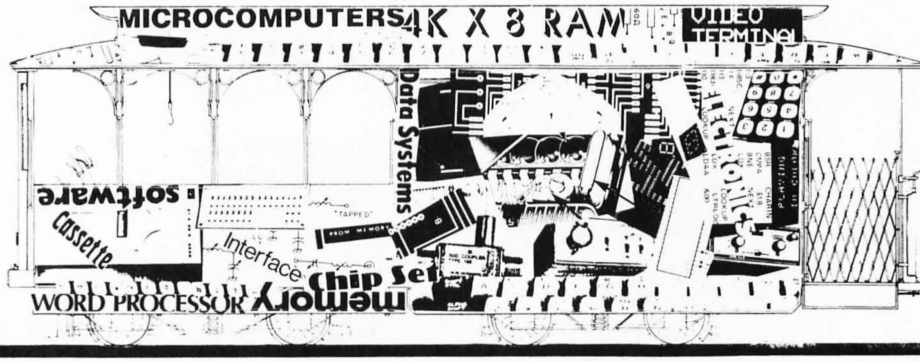
New Directions for Distributors



Semiconductor Specialists Inc, an industrial distributor, will now cater to the home computer enthusiast by establishing twelve MPU Shops at their twelve US branches. The first was opened in the Chicago area at the company headquarters on October 15.

The MPU Shops will have working models of five microprocessor kits, three non-assembled kits, plus four additional microprocessor chips not in kit form. Two complete developmental systems will be available. In addition, books, power supplies, tape readers and accessories in kit form will be carried.

Paul Carroll, president, explains: "The industrial distributor has never really catered to the hobbyist, but always allowed cash sales because many engineers and buyers from industry bought small quantities for their personal use. With the advent of the microprocessor, a whole new market of computer users has developed. These people are engineers, programmers, and technicians from industry who are learning, designing, and programming microprocessor systems at home. They want a place to browse, read, have hands on practice, and see what they are buying. The MPU Shops will have the advantage of supplying many of the extra transistors or ICs they need to input or output their system. The fact that many of these "Computerists" will end up designing and specifying a future system for their employers is why Semiconductor Specialists is interested in this growing market. Mail orders as well as credit cards will be accepted by the MPU Shops. Semiconductor Specialists Inc is located at POB 66125, O'Hare International Airport, Chicago IL 60666.■



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  Golden Gate Chapter
- Stanford University's Electrical Engineering Department
- Community Computer Center
- People's Computer Company

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Using Interrupts to Speed Up an ELM

G H Gable
419 Jackson St
Grand Ledge MI 48837

Software systems are always subject to improvement and extension. The Eloquent Little Monitor is no exception. In the basic ELM monitor, described in my article in June BYTE, page 66, input and output to and from the terminal is handled in a fairly simplistic way. In the case of output, when a byte is ready to be printed, the terminal port is addressed and the byte is dumped onto the IO device. If the terminal is ready, it accepts the byte and prints it. If the terminal is not ready, for instance, if it has not finished printing the last byte, the processor idles, waiting for the terminal to be ready, before actually outputting the byte. If the terminal is a Teletype, it takes 100 ms to print each byte of output. In that time, a typical microprocessor will go through 100,000 machine cycles. Input from the Teletype is even slower because almost nobody can type 10 characters per second. It is easy to see that with such an IO scheme nearly all of the processor's time is spent waiting, either for the next input byte, or for the terminal to be ready to accept the next output byte.

This apparent inefficiency of wasted processor time is not a problem for a dedicated program such as ELM since there is just nothing else for the processor to be doing. The problem, however, might be dramatized in a user program that calculates and prints a series of ten digit numbers. Let us say that each number takes one second to calculate and then one second to print out the ten digits. The real computer time is two seconds per number. During the second second the processor spends most of its time waiting for the printer to be ready. The real time it takes to finish the job could be cut nearly in half if the processor could use the wait periods to be calculating the next number in the series. Such a system is called overlapped output.

The speed problem is just as acute with very fast peripheral devices which handle data at a fixed rate. An example is the disk storage unit. A typical hard surface disk can handle data at the rate of 250,000 bytes per second or 4 μs per byte. Many microprocessors cannot execute even one instruction before the next byte is in position on the disk. If data is stored sequentially on a track, the best the processor can do is access each sequential byte in one plus revolutions of the disk. Such a scheme is 4000 times slower than being able to access each byte as it comes up. Clearly what is needed in this case is the ability for the disk to directly access the central memory in less than 4 μs.

The fundamental object in interfacing peripheral devices with the central processor is to optimize the operation of each unit. Time is the factor which must be handled; first, in the sense of the great speed differential between the peripheral device and the central processor, and second, in the sense that the peripheral device and the central processor are asynchronous; that is, that the device does not start and stop its operation at any specific time relative to the processor. The speed problem is handled by system software which controls the data flow. The asynchronous timing problem requires some control level communications between the central processor and the peripheral device. Such control communications are handled in most computers by an interrupt structure.

Interrupts

Computers are a lot like people in that many of them tend to be very single-minded. It is difficult to talk to them when they are busy doing something else. The processor interrupt is a sort of electronic tap on the shoulder which causes the processor to stop doing whatever it was doing and give the

Some Assumptions . . .

The Eloquent Little Monitor (ELM) extensions as described here are designed to "play" with a computer which has the following hardware features:

- Vectored interrupts.
- Direct Memory Access (DMA) block oriented IO for a tape unit.
- Polled (non interrupt) character input operations.
- Interrupt oriented character output operations, with interrupts taking place at the end of a character's data transfer.

The use of this program with other IO schemes is of course possible, with modifications. For instance, vectored interrupts can be simulated if the source of interrupts is determined in software; a DMA operation could be simulated by explicitly writing a byte by byte block data transfer routine, etc.

shoulder-tapper its undivided attention. This is how the interrupt oriented peripheral device communicates with the central processor. When the device wants to tell the processor something, it first sends an interrupt signal on the control bus and then, in some fashion, transmits the message. When the processor receives the interrupt signal, it stops processing at the end of the current instruction and accepts the message. It then takes some action on the message.

The interrupt structure of the processor and the peripheral device are hardware functions, while the message processing is done by system software. There are many different hardware schemes and, of course, nearly as many software routines as there are computers in the world. Messages are transmitted to the processor via two basic routes. One method will send the message as a set of control signals on a control bus, while the other method sends the message as data on an IO bus. If the interrupt signal is considered as part of the message, then the IO bus route is always augmented by the control bus route.

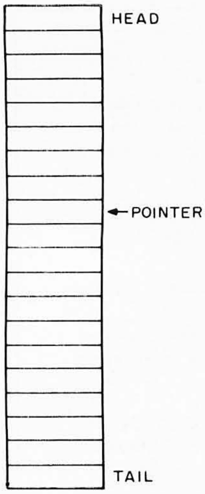
The message essentially has two parts, an identification of the source and the content of the message. There are three commonly used methods for handling the message after it arrives at the processor. One scheme simply causes one bit, determined by the message, to be set in an interrupt register in the processor. This scheme is known as a linear interrupt. It is quite restrictive on small word size machines, but is commonly used on processors with larger word lengths. Another method is to simply store the message in the interrupt register and let software analyze it. The third scheme does not store the message at all, but causes a jump to a location specified by the message. This method is called a vectored interrupt. After the processor has stored the message in the first two schemes, it stores the program counter and jumps to a predefined location to execute an interrupt processing routine. In the third scheme, the processor stores the program counter before making the vectored jump.

In virtually all interrupt structures there is some provision for disabling interrupts, either totally or selectively, by software. This provision is essential because there are times when an interrupt would be inopportune, such as when another interrupt is being processed.

In addition to the message type interrupt, most processors implement some very special interrupts. One of these is the reset line in the control bus. When a signal is put on this line, the processor stops executing the program and jumps (for example) to location zero. This allows the user to manually invoke the monitor at any time jumping to the command processing section of the monitor. At deadstart or after a reset, the monitor is in the command mode.

Direct Memory Access

Another special interrupt often present in general purpose computers is the direct memory access (DMA) hold line in the control bus. A signal on this line halts processing and puts the three state memory data and address buses into a high impedance disconnected state. A peripheral device controller may now directly access central memory for input and output operations. The principal advantage of DMA is that data does not have to pass through the



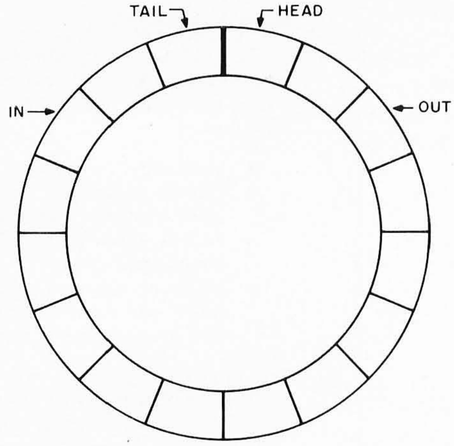


Figure 2: A circular buffer is conceptually a ring although in memory it is actually a region from HEAD to TAIL. Two pointers are maintained for a circular buffer: The IN pointer gives the next available location, and the OUT pointer gives the next location to be used by a processing program. In hardware, a circular buffer corresponds roughly to an integrated circuit called the first in first out memory, sometimes abbreviated FIFO.

Figure 1: A buffer is a temporary place to store data. A linear buffer is a region of memory from locations HEAD to TAIL. When data is processed location by location, a POINTER address variable is used to keep track of the present location.

central processor registers. Input and output can be done essentially at memory access speeds. The controller takes data from sequential memory locations and passes it to the peripheral device, or vice versa. Communication about the status of the device is handled by the normal interrupt line. This all takes fairly sophisticated hardware in the controller, which must be able to count, increment addresses and test to see when an operation is complete. Such capability implies that the controller is actually a special purpose computer processor itself. DMA controllers are often called "intelligent data channels." On many large computers, data channels can actually execute a small instruction set and have their own memories. Current minicomputer peripherals makers often in fact use microprocessors as the DMA controllers of slower speed devices.

DMA can solve the earlier mentioned disk problem where the central processor was too slow for the disk. The DMA controller, with its few simple hardware instructions, can transfer data to and from the disk in less than the 4 μs required.

Buffering

In cases where the peripheral device is considerably slower than the central processor, the data exchange must be carefully controlled. If uncontrolled, the torrent of data from the processor would literally flood the device. Data flow can be controlled by buffering in much the same way that a fast river is controlled by damming. Data can be put into a buffer at processor speeds and then removed at peripheral device speeds and vice versa. Speed buffering is essential for DMA operations. The central memory area accessed by the DMA controller is the buffer. The user program loads or unloads it at processor speeds while the controller loads or unloads it at its speed. Besides speed buffering the buffer implements other desirable features of computer operation. Input line buffering in a monitor such as ELM is particularly important since it allows editing of the line before processing. Output buffering for user applications facilitates the overlap of output operations with program execution.

Input and output buffers can be in user memory, monitor memory or in a peripheral device controller's memory. One, two or all three of these buffer areas may be used in a scheme for input and output. So-called double buffering can be very time efficient at the expense of memory space. In addition to the sequential memory area occupied by the actual data buffer, buffer pointers, parameters and status bytes need to be stored. A buffer memory region has three basic parameters: its starting address (HEAD), ending address (TAIL) and the number of bytes in the buffer (LENGTH). Any two parameters must be known; the third can be calculated. In addition, a variable called the buffer pointer (POINTER) shows which byte is to be accessed next. Status bytes indicate some condition of the buffer, such as ready to be filled, ready to be emptied, etc. (In the figures accompanying this article, the letter P is used for the pointer.)

A linear buffer (figure 1), is simply filled up beginning at HEAD and drained in the same way. Filling always begins at HEAD. After each byte is put in or taken out, the pointer is incremented. A circular buffer can be filled and drained continuously and simultaneously. It has two pointers as shown in figure 2. IN points to the next byte to be filled and OUT shows the next byte to be removed. Of course, the circular buffer is just a linear array operated in a circular way. When a pointer is greater than TAIL it is set

to HEAD. Some ambiguity occurs when IN is equal to OUT; the buffer is either full or empty. Usually, circular buffers are defined as full when they contain LENGTH-1 bytes of data. Needless to say, circular buffers are somewhat confusing and difficult to implement. However, for certain situations they are very efficient.

Physical Records

It is convenient, and sometimes necessary, to transfer data to and from a peripheral device in some standard size block. For instance, a 1403 line printer prints a whole line of 133 characters at a time. It needs to have all the characters in the line before it can print. Such a basic block is called a physical record unit. Most disks are addressed by sector and a typical disk sector holds 256 bytes. Thus, a disk physical record unit would be 256 bytes. The physical record unit size is set by the peripheral device and its controlling hardware and represents the smallest number of bytes to be handled at one time. A serial device such as a Teletype or UART can have a one byte physical record unit, or a larger physical record unit can be defined by the controller. Naturally, buffers for a particular device must be at least one physical record unit long with longer buffers having an integer number of records. To be efficient, a circular buffer will have: LENGTH = (n*PRU)+1, where n is greater than one and PRU is the physical record unit length in bytes.

ELM Extensions

Software control of input and output is best done in the form of user callable subroutines located within a monitor. The remainder of this article describes such

A Vectored Interrupt Example

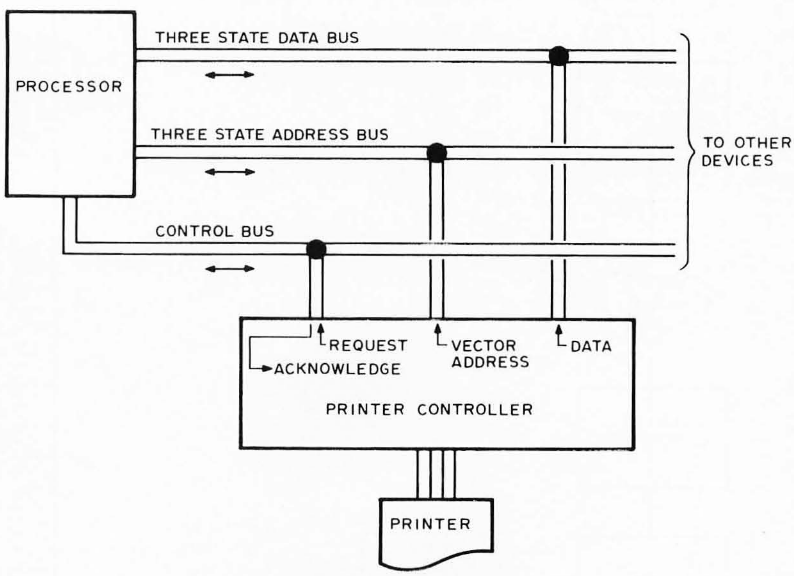
Let's take a look at how a vectored interrupt structure might work on a machine which uses a hardware stack for program control, dedicates a page of memory for interrupt vector jumps, and incorporates a three state system address bus. The diagram illustrates what such a system might look like: a processor, address and system data buses, control bus, and IO devices which have preassigned 8 bit interrupt vector addresses.

Suppose that the controlling hardware for a printer has been set up to produce an interrupt after it has finished printing a character and is ready for the next data byte.

The interrupt is initiated by the printer controller putting a signal on the "wired OR" interrupt line of the control bus. If the interrupts have been disabled, the processor would ignore the signal and the printer controller would keep its request pending until interrupts are again enabled. The processor finally acknowledges the interrupt by putting a signal out on its interrupt acknowledge line to the control bus, and then freeing up the three state address bus by disabling its own buffers.

After receiving the acknowledgement, the printer controller puts the address of its interrupt vector location on the address bus as high order zeros and an 8 bit page 0 address. The processor, which is now synchronized to the controller, reads the address into a temporary register, then again asserts control of the address bus after the printer controller has done its work. The processor then stores the old program counter content by pushing it into the hardware stack, moves the interrupt vector address from the temporary register to the program counter, and proceeds to begin executing instructions at the interrupt vector location.

In this example, the interrupt looks exactly like a subroutine call. The IO device supplies an address in the first 256 locations of memory, which act like a jump table to pick individual device handling routines. Again referring only to this hypothetical example, if each entry in the interrupt vector table takes three bytes, then an interrupt could be vectored to any one of 85 different processing



subroutines in the monitor program. Thus 85 different interrupt messages could be processed with this structure. When processing is completed in such a system, the IO handler subroutine would perform a "return from subroutine" operation to get back to the program which was interrupted at a point just following the last instruction executed before the interrupt. The author's prototype ELM was designed and implemented for a computer with such an interrupt structure.

Vectored interrupt structures of this type can often be found in minicomputers, and sometimes can be adapted to the hardware of a microprocessor system. For example, use of the 8080's RST instruction to select one of eight branch locations following an interrupt is a rudimentary form of vectored interrupt. The primary hardware advantage of a true vectored interrupt is speed; a software simulation is of course possible with a dramatically longer response time.



Figure 3: Buffer Control Block. When buffering is used to allow overlap of processing with IO operations coordinated by interrupts, a buffer control block consisting of two pointers and control flags can be a useful construct. In the ELM case, the first two byte pointer is set to the address of the current user buffer, and the second two byte pointer is set to the address of the current monitor buffer used by the IO routine. The flag called STATUS in the first byte of this five byte control block example is used to coordinate the IO tasks with the user's program.

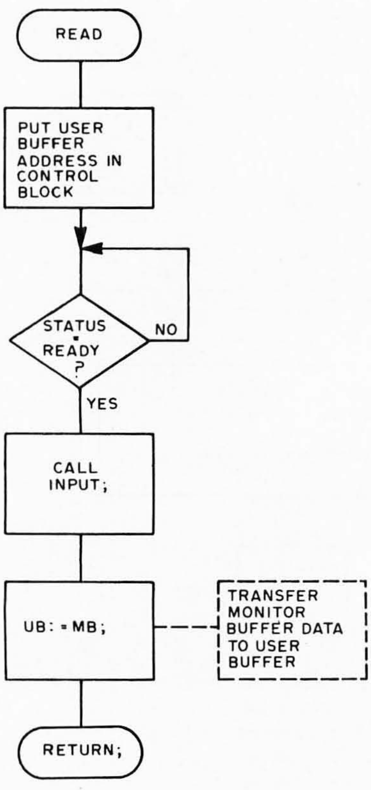


Figure 4: The READ routine specified as a flow chart. In this updated version of ELM, input from the user's keyboard is accomplished using READ. The buffer area called MB is used to accumulate a full line of data. Then the second buffer area called UB is assigned the value just read. Block assignments of this type: UB := MB; can be accomplished either by physically moving the data (slow), or by switching pointers (fast).

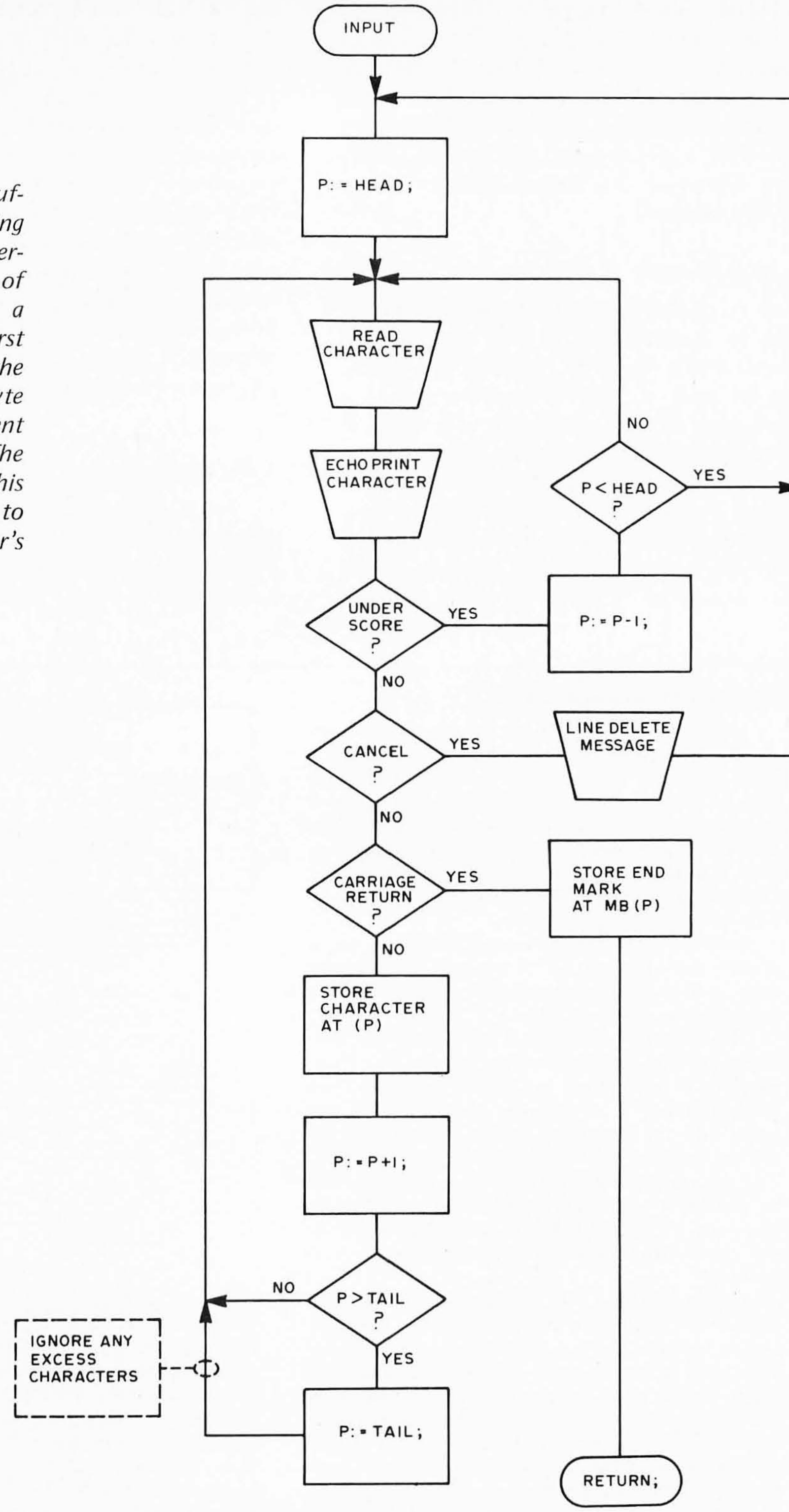


Figure 5: The line INPUT routine specified as a flow chart. This updated version of INPUT (see earlier version given as figure 4 on page 69 of June 1976 BYTE) is written to use the linear buffer MP with control variables HEAD and TAIL, plus buffer pointer P. This version of INPUT also checks for a carriage return end of line indicator, as well as buffer overflow. End of line is indicated by storing of an "end mark" character in the buffer. The notation (P) indicates that address P is being referenced within memory address space. For input and output, (P) is assumed to be within the bounds of MB, the monitor buffer area from HEAD to TAIL. (In the previous article, P was an index value; in this article P is assumed to be a full address value.)

subroutines in the ELM monitor designed with the principal objectives of easy user use and time efficiency.

Even though the basic structure of the monitor subroutines is machine independent, it is necessary to describe them relative to specific hardware. Alterations can easily be made to fit other hardware environments. This particular system has two peripheral devices: a Teletype, which is the human interface, and an incremental tape drive used for mass storage. The central processor is an 8 bit stack machine with vectored interrupts, similar to the machine described in the "Vectored Interrupt Example" accompanying this article.

The Teletype has a hardware controller as part of the interface which transmits and receives ASCII characters whenever addressed. The controller sends an interrupt signal only when it has completed an output operation. The interrupt address transmitted on the IO bus is 3. It also sends a reset signal whenever the escape key (ESC code) is pushed. Input and output with the Teletype is double buffered using linear buffers. One buffer is in the user program while the other buffer, which actually exchanges data with the terminal, is in the monitor. Each buffer is 72 bytes long, a standard Teletype line. When the user program requires input data, it places the address of the head of its input buffer in a central processor register and makes a subroutine jump to the READ subroutine. The monitor reads a line from the terminal into its buffer. This line is completely editable; characters can be removed by the underscore or the whole line can be deleted with CONTROL X, just as in the original ELM described on page 66 of June 1976 BYTE. When the carriage return is received, signalling the end of the line, the whole line is transferred to the user buffer. Output is handled in essentially the reverse order. The user program again puts the address of its output buffer in a processor register and calls the PRINT subroutine. A transfer is made to the monitor buffer and output is begun. The big difference is that output and program execution are overlapped using interrupts.

In addition to the buffer, this new version of ELM keeps a five byte buffer control block as shown in figure 3. The first byte is the status byte which indicates whether the buffer is "ready," "busy" or in "standby." The next two bytes are the user buffer pointer for use by the monitor when making buffer transfers. The last two bytes are the monitor buffer pointer.

Figure 4 shows the user callable subroutine READ. P represents the monitor

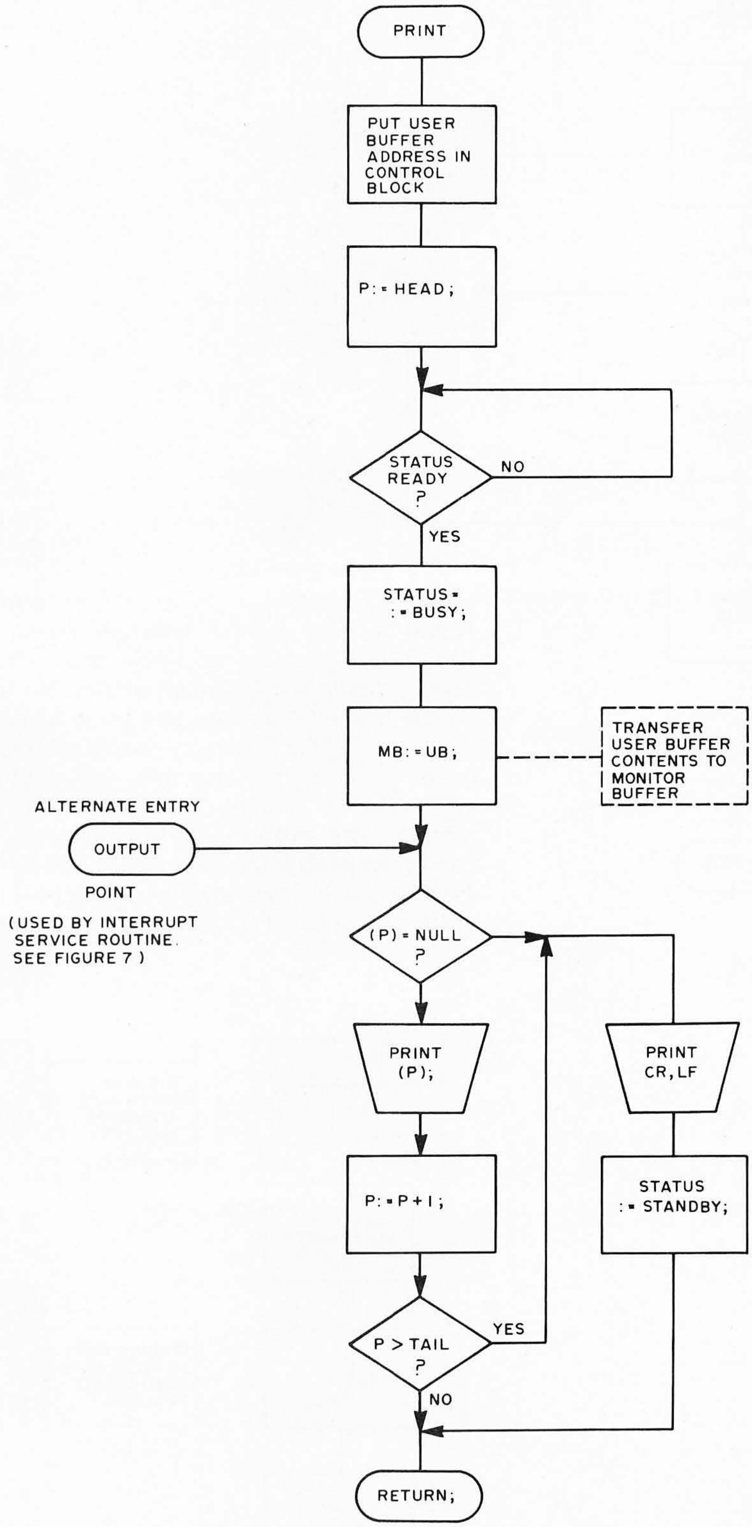


Figure 6: The PRINT routine specified as a flow chart. This routine makes use of the printer interrupt service routine which calls the entry point OUTPUT. Output is started by printing a character; thereafter, output continues as each interrupt causes OUTPUT to be called.

buffer pointer and HEAD is the head of the buffer. This subroutine calls the actual input subroutine INPUT, figure 5, which is the same INPUT described for the original monitor. When the user program calls READ the terminal may still be printing a line of output, thus the status is not ready. A loop at the top of READ waits for the buffer to be ready for the input operation. The input sequence is closed, keeping control until the whole line is read, so it is not necessary to mark the status busy. When reading is complete the line is transferred to the user buffer through the carriage return byte. During the transfer the respective buffer pointers are incremented in the control block.

The output subroutine PRINT is shown in figure 6. There is another subroutine called OUTPUT for the actual output operation. If the output line is less than 72 characters, it is terminated by a zero byte (NUL code). The user buffer is transferred to the monitor buffer from the HEAD through the zero byte. After the transfer the first byte is sent to the terminal and control is returned to the user program. The first byte transfer then begins, to be followed by an interrupt. When the printer is ready for another byte it produces the interrupt which begins execution of the interrupt subroutine shown in figure 7. This subroutine calls OUTPUT for the next byte and again returns control to the user program. Notice that when the last byte is sent, which is a line feed (LF code), the buffer status is marked standby. When the terminal has completed the line feed it sends an interrupt which causes the status to be marked ready again. Virtually complete overlap of output with program execution is achieved.

Both input and output to the Teletype are handled through one monitor buffer since these operations may not occur simultaneously. The user may find it convenient to have separate input and output buffers in the program. There is no conflict because the buffer address is transmitted to the monitor each time a subroutine call is made.

The tape unit of the system assumed here

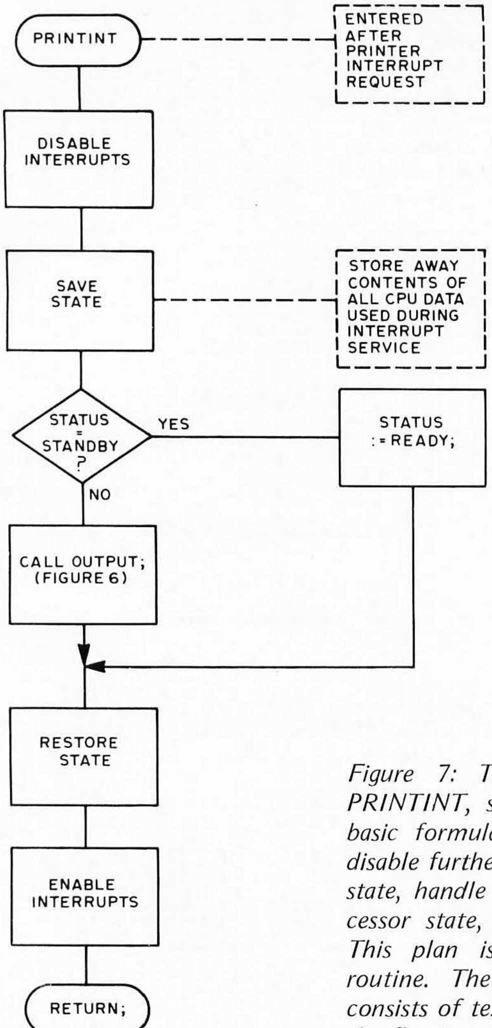


Figure 7: The printer interrupt routine, PRINTINT, specified as a flow chart. One basic formula for an interrupt handler is: disable further interrupts, save the processor state, handle the interrupt, restore the processor state, enable interrupts and return. This plan is evident in the PRINTINT routine. The processing of this interrupt consists of testing the flag byte, STATUS. If the flag is not in the standby state, a byte is written using OUTPUT (see figure 6).

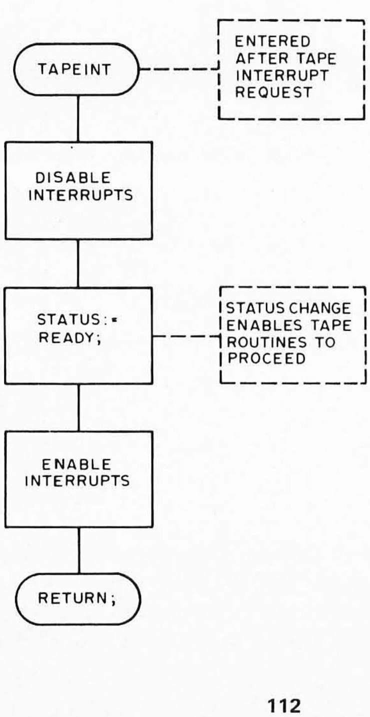


Figure 8: The tape DMA interrupt routine, TAPEINT, specified as a flow chart. In the assumptions accompanying this version of ELM, tape IO is performed by direct memory access (DMA) hardware, which gives an interrupt when the DMA operation is finished. This interrupt means that the hardware is again ready for an IO operation, so the interrupt handler simply sets the tape status to a ready state.

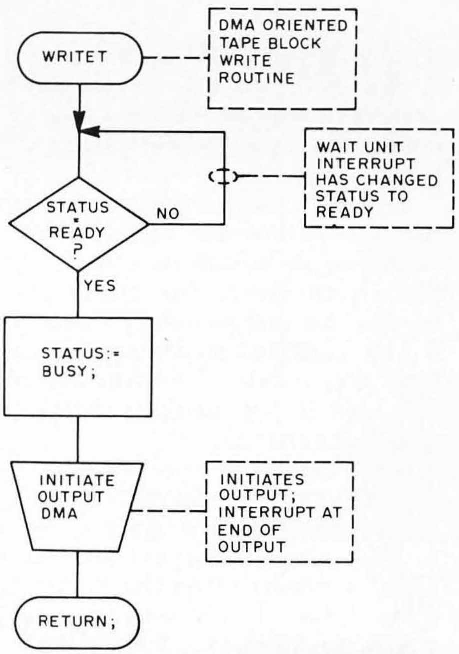


Figure 9: The tape DMA output routine, WRITET, specified as a flow chart. This routine waits until the tape device is ready so that any previous direct memory access IO operation is completed. It then sets the status to the busy state and initiates output DMA by setting up a data pointer and data count through an output port. Processing can continue during the output operation since a direct memory access channel operates independently of the central processor. If a second WRITET call is attempted before the first is completed, the status check finds the busy state until the interrupt at the end of the IO operation is serviced.

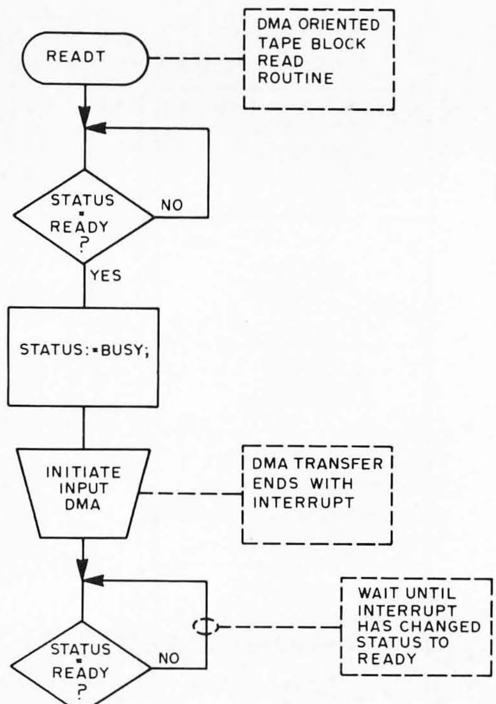


Figure 10: The tape DMA input routine, READT, specified as a flow chart. This routine waits until the tape device is ready so that any previous direct memory access IO operation is completed. It then sets the status to busy and initiates an input DMA operation by setting up a data pointer and data count through an output port. The input routine, however, features a status check loop which waits until the operation is completed. This prevents overlap of input and normal processing.

has a DMA controller which appears only as an output device to the central processor. To start the DMA transfer, the processor transmits three bytes on the data bus to the controller. The first byte indicates whether the operation is input or output. The other two bytes are the central memory address of the buffer. The tape controller will transfer exactly 256 bytes between its own internal buffer and the central memory buffer. During the actual transfer the central processor is held inactive. An interrupt, address 6, is produced when the controller enters the ready state. This would be after the transfer for input and after tape writing for output. Several other utility functions are available, such as skip forward, skip back and rewind. These are implemented by outputting the proper code byte on the data bus when addressing the controller.

The control software is very simple. This is so because the controller hardware is quite complex and does most of the processing. The 256 byte buffer is in the user program. DMA transfer is made directly between the buffer and the controller. The monitor maintains a one byte status block which is either ready or busy. The interrupt subroutine simply sets the status to "ready" as shown in figure 8. When the user program is ready to write out the buffer, it puts the buffer address in a processor register and calls WRITET, which is charted in figure 9. The buffer is transmitted immediately because the status must be ready before the output code byte is sent. Program execution is resumed and overlapped with actual tape writing. Subroutine READT, figure 10, operates much like WRITET, except that it waits until the input operation is complete before returning to the program.

The other utility functions are implemented with subroutines much like WRITET. The physical record unit count for

skip forward and skip back are single bytes in place of the two byte address. Rewind is implemented by just a code byte. These utilities can, of course, be overlapped with program execution.

Figure 11 shows the memory organization for the extended ELM monitor. The extensions are completely compatible with the original design. The scratch pad area contains the addresses and pointers needed for the command processor. The interrupt jump table and stack are machine dependent and apply to the particular hardware described in this article.

The extended monitor should give considerable utility and flexibility for input and output operations. The user program sends or receives logical blocks of data simply by calling a monitor subroutine. A little bonus comes with the implementation of the escape key interrupt which allows the user to reset the central processor from the terminal. This makes it much easier to get out of bad situations. Many types of programs, especially those that do a lot of searching, sorting or calculating between successive outputs, will be spectacularly faster with the output overlap implemented using interrupts and DMA.■

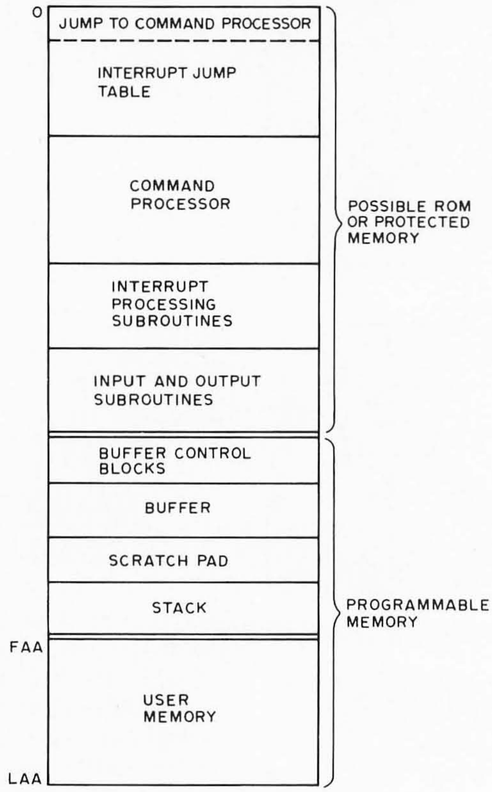
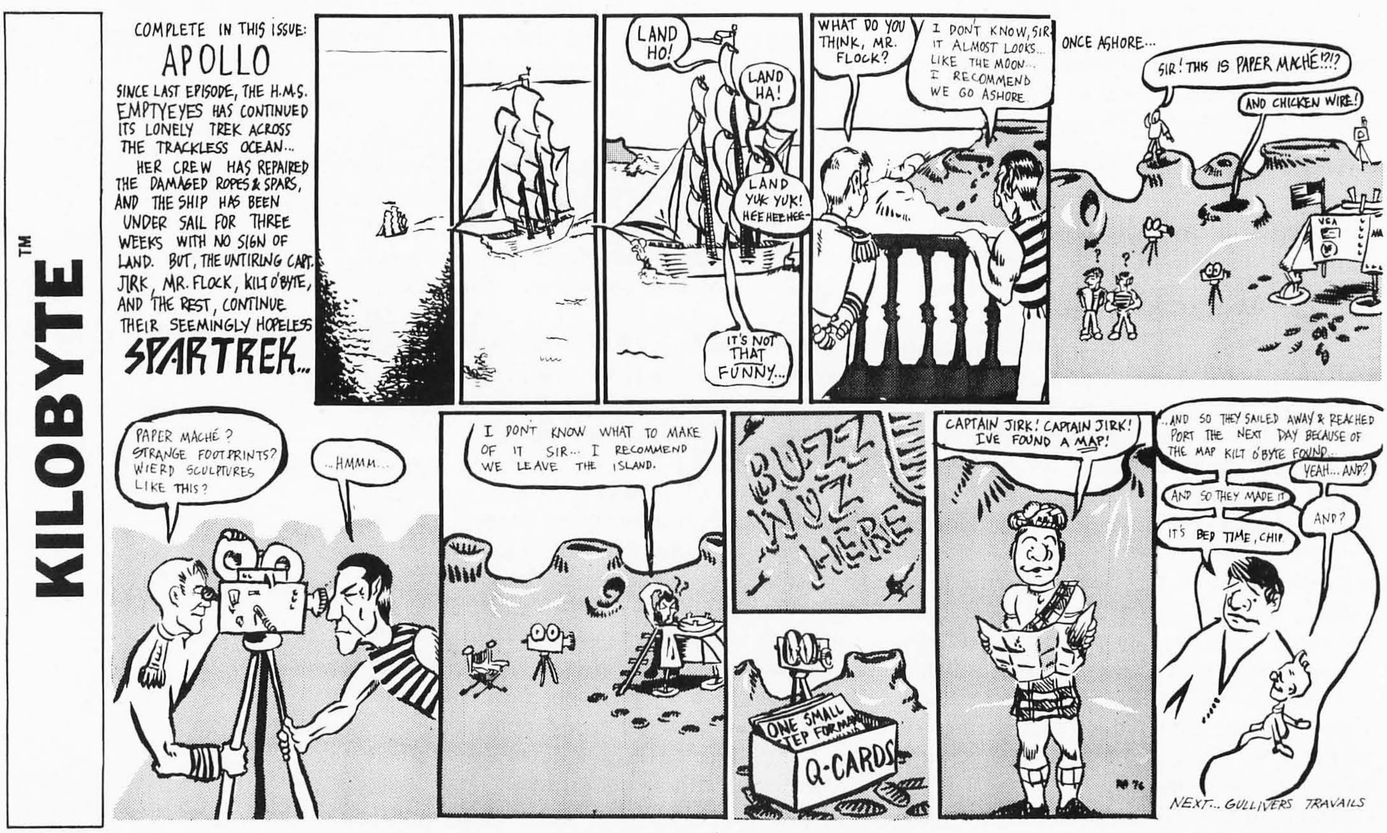


Figure 11: With the design modifications described in this article, the memory map of the ELM program becomes a bit more complicated.



Clubs and Newsletters

Community Computer Communications Australia

Timothy Mowchanuk writes that he and a group of teachers have been given an Innovations Grant by the Australian government for the purpose of developing a low cost minicomputer system suitable for high school use. Part of this grant is also for the printing of a newsletter to act as a communications link between people interested in the field. Tim says that they are complete novices in this type of a venture, and would be very interested in corresponding with others with similar interest. They have not settled on a name for the newsletter but they feel that it will be called *COM-3*, which stands for Community Computer Communications. The address is POB 268, Niddrie 3042 AUSTRALIA.

A Call for Papers and Participation

The First West Coast Computer Faire will be held on April 15-17 1977, at the Civic Auditorium in San Francisco CA. It promises to be a massive one. It is being sponsored in part by the Homebrew Computer Club and the Association for Computing Machinery's Peninsula Chapter, Stanford University's Electrical Engineering Department, the Community Computer Center, People's Computer Company, and the Amateur Research Center. It is expected that the Faire will draw 7,000–10,000 people, will have 50 to 100 conference sessions, and will include over 200 commercial exhibitors. The conference portion of the Faire will include everything from formal papers to informal off-the-cuff talks. There will be a special session on Personal Computers for Education and others of special note on Microprogrammable Microprocessors for Hobbyists and Computer Music.

For lots more information you should contact Jim Warren, general chairperson, and editor of *Dr Dobb's Journal*, at POB 310, Menlo Park CA 94025, (415) 323-3111 or 815-7664; or Bob Reiling, operations chairperson, and editor of the *Homebrew Computer Club Newsletter*, at 193 Thompson Square, Mountain View CA 94043, (415) 967-6754.■

A Computer Hobbyist Club Survey

David Caulkins
437 Mundel
Los Altos CA 94022

Total number of members	153.7
Months since club was founded	10.8 (as of August 76)
Meeting attendance:	
Last meeting	98.6
3 months ago	80.3
6 months ago	48.4
9 months ago	41.4
12 months ago	28.2
New people attending last meeting	14.5
Dues per year	$ 8.60
Number of computers owned by members	33.3
Types:	
Altair 8800	10.7
IMSAI 8080	3.2
SWTC 6800	2.1
KIM-1	1.4
Altair 680	0.9
MIKE	0.3
JOLT	0.1
Other	8.8
Number of items in club library	94.4
Most clubs have a monthly newsletter or magazine; average number of pages	11.8
Number of group buys per year	3.2
Average amount of each buy	$1700

Table 1: Results of the club survey questionnaire. The Southern California Computer Society, SCCS, did not have their full membership averaged in the total number of members category. The reason for this is that with a total membership of 3,000, the membership values would be unreasonably inflated. The SCCS membership was taken as 600 which was the attendance at their last meeting. The total number of computers that are owned by club members is not the same as the total number for the "computer types." The reason for this is that everyone who filled in the number of computers question did not fill in the type of computer that they had. Several people also omitted the very important "other" category.

Table 2: Results of the questionnaire investigating the interest in an organization of clubs. The amount of interest was rated on a scale of 1 to 3 with 3 indicating a great interest and 1 indicating a small interest.

Activity Area	Interest (1 = little, 2 = some, 3 = large)
A central depository and exchange for software, documentation, etc.	2.6
Creation of interchange standards for paper tape, cassettes, floppies, etc.	2.6
Organization of a hobbyist distributed computer network using dial-up lines, packet radio, etc.	2.4
Negotiation with manufacturers for improved quality, price, software, hobbyist oriented architecture, etc.	2.2
Organization and management of hobbyist conventions	2.1

In May, June and July of 1976, a survey was made of hobbyist computer clubs. The intent was to collect data on club size and activities and to evaluate interest in an organization of clubs. I used a mailing list of 52 clubs, sending questionnaires to each; 22 (42.3%) were filled out and returned. During the survey the mailing list grew to 67. Just recently, through the courtesy of Jim Warren of *Dr Dobb's Journal*, I've learned of a club list of approximately 100 members.

Most of the survey questionnaires were filled out by club officers with their best estimates of club size, meeting attendance, etc. After examining the data and doing some cross checking, I would estimate the error of the results given at approximately ±10%. Table 1 gives averages of each of the questionnaire categories; it thus is a profile of the average hobbyist club.

One of the reasons for the survey was to evaluate interest in a club of clubs: a superset organization capable of activities not readily available at the individual club level. Five areas of activity that could be investigated by an organization of clubs were explored by the questionnaire. The results are shown in table 2.

I am especially interested in a hobbyist distributed computer network. Such a network would permit direct computer to computer exchange of data over long distances. This article does not have space for a detailed discussion of the idea, but I believe it to be something hobbyists could do if they wanted to. Much of the research work for this kind of network has already been done under Advanced Research Projects Agency grants. Especially relevant is the ALOHA packet radio work done by Norm Abramson, Frank Kuo and others at the University of Hawaii.

To supplement the questionnaire data, an informal raise your hand type survey covering three areas was made at June and July meetings of the Homebrew Computer Club

1. **Computer Census:**

Meeting Attendance: 300

Type	Number of Systems 9 June	Number of Systems 20 July
8080	53	69
6502	18	24
6800	12	26
Z80	2	2
F8	–	2
8008	6	6
4004	1	1
TTL (from scratch)	1	2
Other	8	8
	101	140

2. **Current Applications, July meeting:**

Application	% of Attendees Actively Involved
Games	30
Scientific Calculation	17
Process Control	13
Text Processing	12
Language Processors	10
Graphics	10
Music	6

3. **Experience Background of Meeting Attendees, July meeting:**

	% of Attendees
Employed as programmers or in computer related fields	50
Employed in electronics or related fields	40
No previous experience with computers or electronics	2
No response	8

Table 3: Results of an informal, raise your hand type survey that was conducted at the June and July 1976 meetings of the Homebrew Computer Club. The average attendance at these meetings was 300 members. Part 2 of this survey gives the type of applications that the members are interested in. Part 3 of this survey gives a general idea of the type of employment and background the members have.

of Northern California. About 300 people attended each of the meetings. The results of this survey are shown in table 3.

Tables 4 and 5 show how the clubs on my mailing list are distributed geographically. As might be expected, there are high concentrations of clubs in the Northeast and on the West Coast.

Wild Speculations and Conclusions

Using the averages of table 1 and assuming there are 100 clubs, one can conclude that the total membership in hobbyist clubs is around 15,000 and that club members possess about 3,300 computers. The club growth rate is also interesting. Plotting meeting attendance averages on semilog paper yields figure 1. The straight line approxima-

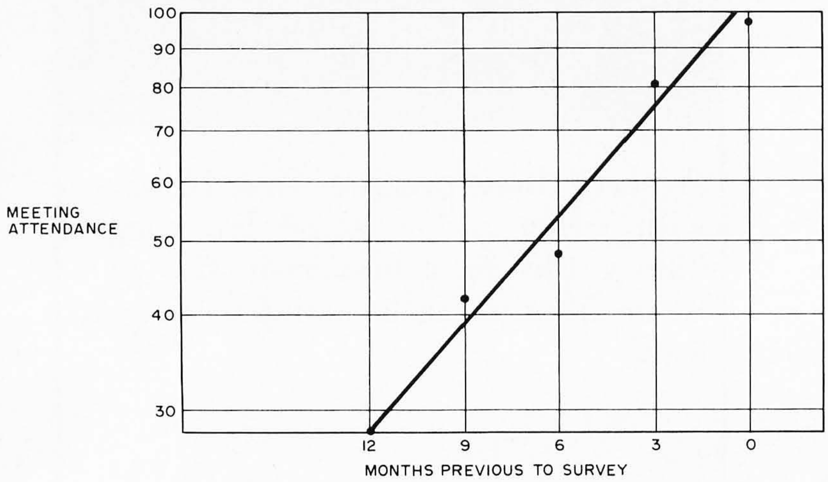


Figure 1: A graph showing the growth of computer hobbyist club attendance. The number of members attending each meeting is plotted against the months previous to the survey. At this rate of growth, the average club meeting attendance should double approximately every six months.

State or Country	No. of Clubs	Questionnaires Sent	Questionnaires Returned
Alabama	1	1	0
California	15	12	2
Colorado	1	1	1
Connecticut	1	0	0
District of Columbia	1	1	0
Florida	4	3	2
Georgia	1	1	1
Hawaii	1	0	0
Illinois	1	1	1
Indiana	2	2	0
Kansas	1	0	0
Louisiana	1	1	0
Maryland	1	1	0
Massachusetts	3	2	1
Michigan	2	1	0
Minnesota	2	2	1
New Hampshire	3	2	0
New Jersey	1	1	1
New York	3	3	3
Ohio	3	2	0
Oklahoma	1	1	1
Oregon	1	0	0
Pennsylvania	2	1	1
Texas	4	4	4
Virginia	2	1	0
Washington	1	1	0
Wisconsin	1	1	0
Canada	5	5	3
England	2	1	0

Table 4: A listing of the number of clubs that are in the US, England and Canada as of the time of this survey, June and July 1976. Along with a breakdown of the clubs by state and country is the number of clubs to which questionnaires were sent and the number of clubs that returned the questionnaires. As might be guessed, and as is borne out by this listing, there is a concentration of clubs on the West Coast and in the Northeast.

tion indicates that the time for average club meeting attendance to double is about six months. The doubling time can be calculated a different way, using the number of new people at each meeting. Assuming that 50% of these people become members, the projected time for club meeting attendance to double is a little over ten months. In either case, indications are that computer hobbyist club membership is growing at a rapid rate. Like all growth curves this one must sooner or later level out. The survey has some faint evidence of this: larger club, membership in the 200 range, meeting attendance seems to be increasing at a lower rate than that of smaller clubs.

Who are the computer hobbyists? The Homebrew Computer Club survey would seem to indicate that the great majority have some kind of contact with computers or electronics other than their computer hobby.

I think the computer hobby movement will have a substantial and good effect on the way computers are used. Too many of us who work with them professionally have come to regard ourselves as a high priesthood presiding over sacred mysteries. Sacred mystery keepers have a bad habit of knowing all the reasons why something can't be done; hobbyists do not have the burden of this knowledge. The survey shows rather clearly that there are many more hobbyists than there are university graduates in computer science. I hold the radical view that an hour spent debugging one's own machine or program is worth ten hours of lecture about how to do it. So again, I think this is a good thing. There are dangers. The computer game already has an oversupply of hackers: programmers who write code, totally unreadable by anybody but themselves, that works almost all of the time.

My thanks to all the club people who were kind enough to fill out and return the questionnaire.■

States With No Hobbyist Clubs on Mailing List

Alaska	Nevada
Arizona	New Mexico
Arkansas	North Carolina
Delaware	North Dakota
Idaho	Rhode Island
Iowa	South Carolina
Kentucky	Tennessee
Maine	Utah
Mississippi	Vermont
Missouri	West Virginia
Montana	Wyoming
Nebraska	

Table 5: Table of those states that do not have computer hobbyist clubs on the questionnaire mailing list.

Clubs and Newsletters Directory

Here it is, the first BYTE Clubs and Newsletters Directory. This listing was compiled by Floyd Rehling from information supplied by the various clubs listed. We ran some requests for data from clubs in earlier issues, data which sets the content of the information in this listing. Not all clubs responded to the printed requests for information. This listing was correlated with back issues of the magazine and materials on file in the BYTE offices. An occasional duplication or outdated bit of information may have crept in. In the listing of the clubs, information missing in one or more of the categories indicates exactly that: We have no information. We'll be keeping the file available and updating it for the next shot at publication in the magazine, one year from now; so if there are errors or if you have a new club which has just been formed, send the information to us.

The listings follow this form:

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

Zips 00000 – 10000

1. Caribbean Computer Club
2. 52 Kings Ct 4A
   Santurce PR 00911
3. Same as above
4. First Saturday of each month
5. *Bits n' Bytes*
6. John St Clair
7. (809)722-1424
8. $20 (includes subscription to newsletter)
9. Microcomputers, word processing
10. 10 members
    Club plans to purchase microcomputer for members.

1. New England Computer Society
2. POB 198
   Bedford MA 01730
5. *The Computerist*
6. Robert M Tripp
   POB 3
   S Chelmsford MA 01824
8. $6 per year

1. Alcove Computer Club
2. 230 Main St, Rt 28
   North Reading MA 01864

1. Boston Area Group
2. 21 Sunset Av
   North Reading MA 01864

1. University of Hartford Microcomputer Club
2. College of Engineering – Dana Hall
   200 Bloomfield Av
   West Hartford CT 06117
3. Room 123 Dana Hall
4. 3rd Tuesday at Common Hour 11 AM
5. *U HA BYTE*
6. John Paul Froehlich, asst prof EE
7. (203)243-4681
9. Sincere interest in microprocessor applications, games and abstract applications
10. Current officers: president, Bryan Moffitt; vice president, Jeffrey Katz; secretary, Richard Rynaski; publications director, Mark Dalphin.

1. Southern New England Computer Society
2. 267 Willow St
   New Haven CT 06511
3. First three meetings: New Haven, East Hartford, Windsor Locks
4. Monthly, 1–5 PM on a Sunday afternoon.
5. Newsletter: *Yankee Bits*
8. Four issues for $1
10. Probably meet anywhere in southern New England if invited; Saturday meetings a possibility. Information on our next meeting will be sent at no charge to anyone in CT or western MA. SNECS news is published in *The Computerist*.

1. Amateur Computer Society
2. 260 Noroton Av
   Darien CT 06820

1. Connecticut Microists
2. 60111 Wendy Ln
   Westport CT 06880
3. Members offices in Fairfield County
4. Second week of the month; date set at previous meeting
5. *Microbitz*
6. George Ahmuty
7. (203)227-8534
8. $2
9. Develop interfaces, expand basic usage to commercial uses, and send speakers to local high schools, etc.
10. Develop a buyers guide, available to other clubs

1. Northern New Jersey Amateur Computer Group
2. Murray P Dwight
   593 New York Av
   Lyndhurst NJ 07071
3. Fairleigh Dickinson University
   Becton Hall
   Rutherford Campus NJ
4. Second Friday of the Month
   6:30–11 PM
8. $5

1. Amateur Computer Group of New Jersey Inc
2. 1776 Raritan Rd
   Scotch Plains NJ 07076
3. We hold three meetings every month, as follows:
   General membership meeting: (includes guest speaker and flea market: attendance typically 130–200). Held third Friday of month at various colleges in state – schools most frequently used are: Union County Technical Institute, Scotch Plains and Middlesex County College, Edison.
   User Groups: (informal mutual help sessions for users; can bring down their equipment or software for debugging)
   8080/Z80 User's Group: meets first Friday evening of month at Union County Technical Institute, Scotch Plains (attendance typically 40–50).
   6800 User's Group: meets fourth Friday evening of month at Chuck Wolff's, 26 Willow Dr, Apt 6A, Ocean Township.

Annual Festival: held at Trenton State College in May (last fest had attendance of 1,500 with 45 exhibitors, 25 speakers and flea market)

5. *ACG-NJ NEWS*; published monthly
6. General membership meetings, etc:
   Sol Libes
   day: (201)889-2000 x-247
   eve: (201)277-2063
   Marty Nichols
   day: (201)994-3100 x-218
   eve: (201)361-7180
   8080/Z80 User Group:
   Dennis Dupre
   eve: (201)688-9254
   6800 User Group:
   Chuck Wolff
   day: (201)842-1900 x-291 (3–5 PM)
   Software Librarian:
   Tom Kirk
   eve: (201)246-4242
8. Dues: $2 for 1976
10. Approximately 500 members

1. Holmdel Microprocessor Club
2. Fred Horney
   Rm 3D317
   Bell Telephone Labs
   Holmdel NJ 07733
3. Bell Labs Holmdel
4. As needed
5. *Bits, Nybbles, and Bytes*
6. See No. 2
7. (201)949-7845
8. None
10. This is a Bell Labs sponsored club.

1. New Jersey Club
2. Bruce C Dalland
   37 Brook Dr
   Dover NJ 07801

Zips 10000 – 20000

1. New York Micro Hobbyist Group
2. Bob Schwartz
   375 Riverside Dr #1E
   New York NY 10025
5. Newsletter
7. (212)663-5549

1. New York Amateur Computer Club
2. 106 Bedford St
   New York City NY 10014
3. 33 W 42nd St Manhattan
   NY Graduate Center
4. Second Thursday each month 7 PM
5. *Notes*
6. Ed Enck, president
7. (212)255-4942
8. $10
9. Interchange of information

1. Westchester Fairfield Amateur Computer Society
2. RR 1, Box 198
   Pound Ridge NY 10576
3. Greenburgh Public Library, Elmsford NY
4. Varies; but plan on first Tuesday of the month
5. None as yet
6. Carlton B Hensley
   Pheasant Rd W
   Pound Ridge NY 10576
7. (914)PO4-4213
8. Family membership $7; full time student $3
10. Visitors welcome; bring your computer or computer gear.

1. Harold Shair
2. 41 Colby Av
   Rye NY 10580

1. Long Island Computer Association
2. 36 Irene Ln E
   Plainview NY 11803
3. New York Institute of Technology
   Westbury LI 11568
4. Third Friday of the month
5. *The Stack*
6. Gerald S Harrison, president
7. (516)938-6769
8. $10 regular member; $5 full time student per year

1. Niagra Region Computer Group
2. Chuck Fischer
   355 S Creek Dr
   Depew NY 14043
7. (716)681-1597

1. Students Cybernetics Lab
2. 16 Linwood Av
   Buffalo NY 14209

1. RAMS (Rochester Area Microcomputer Society)
2. POB D
   Rochester NY 14609
3. Rochester Institute of Technology, Building 9, rm 1030
4. Second Thursday of every month at 7:30 PM
5. *Memory Pages*, monthly newsletter
6. Dave Noderer
7. (716)244-9844 evenings and weekends
8. $5 annual dues includes the newsletter.
9. As yet we don't have any special interest groups but plan on forming some within the next 2–3 months. The major portion of our meeting is a presentation of a microcomputer application or a lecture on a specific microprocessor.
10. We hope to interact with other computer clubs in the following areas: Newsletter exchange, group purchase power, organization of regional computer fests, conferences, etc.

1. Ithaca Computer Group
   204 Dryden Rd
   Ithaca NY 14850
2. Steve Edelman

1. Pittsburgh Area Computer Club
2. 400 Smithfield St
   Pittsburgh PA 15222
3. 821 Old Wm Penn Hwy
   Murrysville PA
   (Basement of building)
4. Meetings are on the second Sunday of each month. The formal meeting starts at 1 PM. Come early (11 AM) for coffee and an informal display of members' equipment.
6. Fred Kitman (412)391-3800 days or Harry Kohman (412)931-5866 evenings
10. Our meetings will provide you a chance to work with computers and give you important technical data, on both how to build a computer and how to program your machine once it's built. Through other members you'll become aware of surplus computer bargains and you'll be able to take part in group purchases of equipment at quantity prices. Our monthly newsletter will keep you informed between meetings and contains informative software and hardware articles.

1. Delaware Chapter – Southern California Computer Society
2. Martin Dimmerman
   1228 Barrowdale
   Rydal PA 19046

1. Philadelphia PA Area Club
2. 404 Quince St
   Philadelphia PA 19147
6. Richard Moberg
7. (215)829-6744 work
   (215)923-3299 evenings

1. Philadelphia Area Computer Society (PACS)
2. POB 1954
   Philadelphia PA 19105
3. Meeting locations vary.
4. Meetings are held every three weeks on alternate Saturday afternoons and Thursday evenings.
5. *The Data Bus* (monthly newsletter)
6. Dick Moberg, president
7. (215)923-3299
8. Dues: $10 regular member; $5 student member
10. PACS was formed early in the summer to cater to the needs of computer hobbyists, students, and professionals in the Philadelphia area. Our monthly newsletter, *The Data Bus*, offers tutorial articles, book reviews, meeting announcements, and classified ads. At our meetings you can expect a regular flea market, talks about products and experiences, tutorials, and mapping sessions. Field trips to MOS Technology and to the Moore School (ENIAC birthplace) and a computer fair are being planned.

Zips 20000 – 30000

1. Washington Amateur Computer Society
2. Robert J Jones
   4201 Massachusetts Av NW #168
   Washington DC 20016
4. WACS meets the last Friday in every month year 'round at the Catholic University of America in the computer center located at 3329 8th St NE, at the corner of 8th and Lawence St NE. The society also meets informally at the computer center on the Fridays following.
5. *The Washington Amateur Computer Society Newsletter*
6. Robert J Jones, president
   Address see No. 2
   William K Stewart
   5910 2nd St NW
   Washington DC 20011
7. (202)722-0210
8. We have limited financial resources.

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

Should anyone desire a copy of our newsletter, please enclose $.26 per copy; for every $.26 you send, we'll extend your subscription.

9. It seems at this time that the president of the club is now the Ralph Nader of the hobbyist world. He tries to keep all of us informed on the types of service the hobby vendors are giving to those of us who pay our hard earned green stamps to those seemingly speedy delivery types, and XYZ compatible manufacturers. He also has compliments for the good guys.
10. The club is open to all who are interested in, or desire to learn about computers, large or small. On any typical Friday evening (or any other evening for that matter), you will find several members of the club engaged in conversation over some new piece of hardware, or discussing ways to beat the Lunar Lander game at the computer center. If anyone has any inquiries, just drop us a line. BUT PLEASE . . . enclose a self addressed stamped envelope with your request.

1. Chesapeake Microcomputer Club Inc
2. 236 St David Ct #4
   Cockeysville, MD 21030
4. Chesapeake Microcomputer sponsors a general membership meeting on the second Wednesday of each month; local chapter meetings occur throughout the month.
5. *Analytical Engine*
6. **Maryland**
   General Membership:
   Philip N Hisley (301)667-9690
   Baltimore Chapter:
   Philip Sticha (301) 682-6000 x-304
   Wheaton Chapter:
   Mani Alexander (301)946-4120
   Laurel Chapter:
   Dan Messina (301)766-3202
   Washington DC
   Washington Amateur Computer Society:
   Bob Jones (202)537-1984
   (after 10 PM)
   Virginia
   McLean Chapter:
   Martin Buchanan (703)893-7978
   Jim Greene (703)790-6231
   Reston Chapter:
   Andrew Convery (703)860-1879
   Richmond Chapter:
   Hugh Melton (804)285-2452
8. Published bi-monthly
   Subscription: $6 per year;
   Dues: $12 per year (includes subscription)

1. Chesapeake Microcomputer Club Inc
2. Richard A Kuzmack
   1435 Layman St
   McLean VA 22101
7. (703)821-2873

1. Amateur Radio Research and Development Corporation (AMRAD)
2. 1524 Springvale Av
   McLean VA 22101
3. Patrick Henry Library
   Maple Av at Center St
   Vienna VA
4. First Monday of each month at 8 PM (except holidays)
5. (Nameless, but we're thinking)
6. Paul L Rinaldo K4YKB
7. (703)356-8918 evenings and weekends
8. $10 per year or $100 life
   $5 per year or $50 life for second in family
   $2 per year for student
9. State of the art technology, computers, radioteletype repeater, technical symposia
10. Despite "Amateur Radio" in name, we spend more than 1/2 of our meetings on computer subjects. Maybe in 1977, if FCC permits it, we hope to have a computer on-line on our RTTY repeater WR4APC, McLean VA.

1. Washington–Baltimore Computerhobbyist Club
2. R Rubenstein
   7711 Elba Rd
   Alexandria VA 22306

1. Charlottesville Computer Hobbyists Club
2. POB 6132
   Charlottesville VA 22906
3. To be determined
4. Second Friday of each month (probable)
5. None at present
6. Pat Seitzer
7. (804)293-4973
8. To be determined
9. None
10. The club has just been formed.

1. IBM 5100 Users Club
2. Richard Easton MD
   5541 Parliment Dr #104
   Virginia Beach VA 23462

1. Peninsula Computer Hobbyist Club
2. Larry Pollis
   2 Weber Ln
   Hampton VA 23663

1. Dyna-Micro Users Group
2. Dr Frank Settle Jr
   Box 1053
   Lexington VA 24450

1. Triangle Amateur Computer Club
2. POB 17523
   Raleigh NC 27609
3. Dreyfus Auditorium
   Research Triangle Institute
   Research Triangle Park NC
4. Fourth Sunday at 2 PM
5. Monthly newsletter
6. Russell O Lyday Jr
7. (919)787-4137

Zips 30000 – 40000

1. Atlanta Area Microcomputer Club
2. 421 Ridgecrest Rd
Atlanta GA 30307
6. Jim Dunion

1. Atlanta Area Microcomputer Hobbyist Group
2. Jim Stratigos, editor
POB 33140
Atlanta GA 30332

1. Jacksonville Computer Club
2. Regency East Office Park
9951 Atlantic Blvd Suite 326
Jacksonville FL 32211
3. See #2
4. Second Saturday of each month at 2 PM
5. In the flowchart stage
6. Carey Douglas
7. (904)725-8158
8. $5 per quarter
9. Community interests in computer arts and sciences
10. Everyone is welcome to meetings.

1. Tallagassee Amateur Computer Society
2. Larry Hughes
Rt 14
POB 351-116
Tallagassee FL 32304

1. University of Florida Amateur Computer Society
2. Electrical Engineering Department
Rm 234 Larsen Hall
Gainesville FL 32611
3. Student Union
6. Steve Ackerman or Ken Massey
10. Direct all correspondence to persons above until a permanent mailing address is established.

1. Space Coast Microcomputer Club
2. Ray O Lockwood
1825 Canal Ct
Merritt Island FL 32952
7. (305)452-2159

1. South Florida Computer Group
2. 410 NW 117 St
Miami FL 33168
5. *I/O*
6. Dr Bruce Cameron, editor
8. Dues: $5 per year or $2 per year for students (includes subscription to newsletter, as well as exchange of newsletters with other clubs); non-members may receive I/O at $2 per year (12 issues).

1. Micro Computer Society of Florida
2. POB 3284
Downtown Station
Tampa FL 33604
3. Marsh Data Systems
5405B Southern Comfort Blvd
Tampa FL
4. First and third Saturdays each month at 2 PM except July, August and September (third Saturdays only)
5. *I/O MAGAZINE*
6. R Larry Miner
7. (813)343-2973 after 6 PM
8. Dues: $5 per quarter; special student rates available
9. All areas, including homebrew, voice recognition and all major high level languages
10. Society chapters are located in: Tampa, Vero Beach, Ft Meyer, Sarasota, Jacksonville and Gainsville. All welcome.

1. NACC
2. 1409 Blevins Gap Rd SE
Huntsville AL 35802
6. Jack Crenshaw

Zips 40000 – 50000

1. Louisville Area Users of U Comp
2. Steve Roberts
POB 18065
Louisville KY 40218

1. Amatuer Computer Society of Columbus Ohio
2. See #6
3. Center of Science and Industry
4. First Wednesday of every month
5. *I/O*
6. Walter Marvin, president
408 Thurber Dr W
Columbus OH 43215
(614)461-0535
Richard Damon, treasurer
(contact for membership)
2193 Farleigh Rd
Columbus OH 43221
(614)486-1551

1. Cleveland Digital Group
2. 8700 Harvard Av
Cleveland OH 44105
3. 8700 Harvard Av
4. 2 PM on the third Sunday of every month
5. *The Shift Register*
6. Lou O'Block
7. (216)232-9055
8. $10 per year
9. All aspects of hobbyist computers for persons in the northeast Ohio area.
10. The club has an impressive list of past and future group purchases, and is building a library. Current plans call for evening and weekend hours at our clubhouse for interested members. The club is a member of the Midwest Affiliation of Computer Clubs and is active in its affairs, including the first and second annual Midwest Regional Computer Convention.

1. Universe Unlimited Group
2. 11981 Forest Av
Cleveland OH 44120

1. KIM Users Group
2. Eric Rehnke
7656 Broadview Rd Apt 207
Parma OH 44134
5. *KIM-1 Users Notes*
10. The users group will act as a vehicle for users to exchange hardware and software ideas as well as experiences with interfacing the many peripherals now becoming available.

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

1. The Midwest Affiliation of Computer Clubs
2. POB 83
Cleveland OH 44141
3. Board of trustees meeting held at the annual Midwest Regional Computer Convention
5. Private communication and correspondence only
6. Gary Coleman, president
7. (216)371-9304
8. None
9. Coordination of activities between member clubs
10. The MACC is a central organizing body for the many computer clubs in the states of OH, PA, IL, KY, IN, NY, MI, WI and CANADA. The MACC held its first annual Midwest Regional Computer Convention in Cleveland last June, and will hold the second one again in Cleveland during June of 1977. The MACC will be coordinating other activities such as group purchasing in the near future.

1. Cleveland Digital Group
2. 1200 Seneca Blvd #407
Broadview Heights OH 44147
5. *The Shift Register* (Eric Rehnke, editor)
6. John E Kabat Jr
7. (216)888-7531

1. Dayton Microcomputer Association (DMA)
2. Doug Andrews
8668 Sturbridge Dr
Cincinnati OH 45236
7. (513)791-6169

1. Compute, Evaluate, Trade
2. POB 104
Tipp City OH 45371
3. Rotate in members homes
4. First Saturday in the month for the first 12 months of each year, with my wife's approval
5. *Byte Back*
6. Charles E Tyzzer Jr
7. (513)268-6551 x587
9. Talent and a desire to exchange information; business application

1. SR-52 Users Club
2. 9459 Taylorsville Rd
Dayton OH 45424
4. No organized meetings
5. *52–NOTES* (monthly)
6. Richard C Vanderburgh, editor
7. (513)233-3698

8. Contribution of $6 for membership and six newsletters
9. Our purpose is to Help SR52, SR56, PC100 owners/users get more out of their TI pocket programmables by exchanging ideas.
10. First newsletter: June 1976

1. Indianapolis Small Systems Group
2. 54 Sherry La
Brownsburg IN 46112
3. Linde Division of Union Carbide
Speedway IN
4. Second Wednesday of each month 7:30 PM. Meet at main entrance on 16th St.
5. *The INDY BYTE CHASER*
6. Keith Pieper
7. (317)852-5833
8. None; subscription fee for newsletter $1.50 (six monthly issues)
9. Learning about and applying small computer systems
10. If you have suggestions as to reaching further members, obtaining speakers for programs and donations of equipment, etc, we would appreciate hearing them either as an article in BYTE or as a direct communication to us.

1. The Floyd County Computer Enthusiasts
2. Nathan Engle
RR#2 POB 466A
New Albany IN 47150
7. (812)923-8066
9. Out interests lie mainly in games and system expansion. The members of our group are on very low budgets, but are interested in buying low cost hardware and software.

1. Louisville Area Users of Micro-Processors (LUMP)
2. Andy Ehalt
115 Edgemont Dr
New Albany IN 47150
7. (812)945-4307

1. Hoosier Amateur Computer and Kluge Society
2. Ray Borrill
111 S College Av
Bloomington IN 47401

1. Beta Iota Tau
2. Richard A Petke
RHIT
POB 420
Terra Haute IN 47803

1. Purdue University Computer Hobbyist Club (PUNCH)
2. Rm 67 Electrical Engineering Bldg
Purdue University
West Lafayette IN 47907
3. Digital lab of the electrical engineering building
4. Weekly
10. Membership is limited to the student body, but visitors are welcome.

1. Detroit Area Club
2. Dennis Siemit
45466 Custer
Utica MI 48087

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

1. Ann Arbor Computing Club
2. Roger Gregory
1485 Newport Rd
Ann Arbor MI 48103
7. (313)995-5743

1. Southeastern Michigan Computer Organization (SEMCO)
2. POB 9578
North End Station
Detroit MI 48201
3. WJBK TV-2 Studio
Southfield MI
4. The second Sunday of the month at 6 PM
5. *Data Bus*
6. Mr Richard Weir
7. (313)465-3228
8. $10 per year
9. Club interests cover the whole spectrum of microprocessors; members own systems from many manufacturers. The background of members range from novice to hardware designer.
10. Club is six months old, has about 110 members, and is a member of MACC.

1. Mid-Michigan Computer Club
2. 15151 Ripple Dr
Linden MI 48451
6. Tony Preston
7. (313)629-5361 X-262
10. We are in the embryo stage.

1. Jackson Hams and Hackers
2. Commonwealth Associates Inc
209 E Washington St
Jackson MI 49201
3. Place: variable
4. Times: spontaneous/variable
6. Jess Hancock WB8RDF
(517)787-5950
Rick Cook (517)787-5950
9. General, ham, games, mathematical
10. We are an informal group of 6 to 8 persons interested in microprocessors, 1 KIM-1, and a 6502 based homebrew in the planning stage.

Zips 50000 – 60000

1. The Eastern Iowa Computer Club
2. 6026 Underwood Av SW
Cedar Rapids IA 52404
6. Mike Wimble, president
7. (319)395-4392 work
(319)396-5647 home

1. Wisconsin Area Tribe of Computer Hobbyists
2. Don Stevens
POB 159
Sheboygan Falls WI 53085

1. Bit Users Association
2. 3010 4th Av S
Minneapolis MN 55408

1. Advanced Technology Research Associates (ATRA)
2. POB 456
Minneapolis MN 55440
3. 2633 Dupont Av S, Mnpls, subject to special visits to other organizations announced in advance
4. Tuesdays at 7:30 PM, with special exceptions announced in advance
5. None at this time
6. Frank Stodolka
7. (612)377-7387
8. BYOB
9. PLATO and graphics, word processing, physics (fusion, energy conservation, lasers), futurism and alternate economic systems for an automated society, invention patenting and marketing. (All in addition to home computer systems, of course.)
10. All our members are science fiction fans. Our meetings are basically information exchange and brainstorming sessions. Any fans out there good at digital circuit design and construction?

1. XXX-II Users Group
2. Dick Corner
514 S 9th St
Moorhead MN 56560

1. Southeast Minnesota Club
2. 2122 NW Av
Rochester MN 55901

Zips 60000 – 70000

1. Chicago Area Computer Hobbyist's Exchange
2. Bill Precht
POB 36
Vernon Hills IL 60061
5. *Cache Register Newsletter*
7. (312)356-7290

1. Chicago Users Group
2. 195 Ivy Ln
Highland Park IL 60035

1. ALTAIR – CHICAGO
2. 517 Talcott Rd
Park Ridge IL 60068
3. Chicago Computer Store
517 Talcott Rd
Park Ridge IL 60068
5. *Computer Notes – Chicago*
6. Lou Van Eperen
7. (312)823-2388
8. Altair owners – free; assoc. members – to be determined
9. Clinics, seminars, problem solving, applications, software, etc, as related to Altair equipment
10. The club will be primarily designed to aid the Altair owner and offer a cooperative effort to get the most use out of the Altair System. Non-Altair owners and those contemplating purchase of an Altair are cordially invited to attend as associate members on a limited basis.

1. Chicago Micro Users Group
2. 1102 S Edison
Lombard IL 60148

1. Ice-Nine Inc
2. POB 291
Western Springs IL 60558

1. Microcomputer APL Enthusiasts (MAPLE)
2. POB 574 NUMS
303 E Chicago Av
Chicago IL 60611
4. We meet bimonthly via the newsletter.
5. *MAPLE Leaves*
6. Ruth Low, editor
8. $3 for four issues (1 year)
9. First: developming a μAPL; then, foreign languages, graphics, speech synthesis, music synthesis, etc.

1. The Computer Network of Kansas City
2. 968 Kansas Av
Kansas City KS 66105
5. *K C Thru – Put*
6. Earl Day
7. (913)492-9315

1. South Central Kansas Amateur Computer Association
2. 1504 N St Clair
Wichita KS 67203
3. 1430 E Kellogg
Wichita KS 67203
4. First and third Saturday of the month
5. *Data Link*
6. Cris Borger
7. (316)945-9658
8. Dues: $10 (includes subscription fee)

Zips 70000 – 80000

1. Crescent City Computer Club
2. POB 1097
University of New Orleans
New Orleans LA 70122
3. Room 2120 Science Building of the University of New Orleans
4. Second Friday of each month at 8 PM
6. Emile Alline WA5 WUJ
1119 Penn
Slidell LA 70458

1. Central Oklahoma Amateur Computer Society (CENOACA)
2. Lee Lilly
POB 2213
Norman OK 73069
3. Oklahoma City Warr Acres Branch Library at NW 63rd and MacArthur, Oklahoma City OK
4. The second Saturday of each month at 10 AM
5. *Newsbits*
7. (405)364-1071
8. Subscription is included in annual association dues of $5.

1. Oklahoma City Club
2. 2412 SW 45th
Oklahoma City OK 73119

1. Dallas-Fort Worth Club
2. 2377 Dalworth Apt 157
Grand Prarie TX 75050

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

1. The Computer Hobbyist Group of Northern Texas
2. Bill Fuller
   2377 Dalworth #157
   Grand Prarie TX 75050

1. Houston Amateur Microcomputer Club (HAμCC)
2. 4223 SW Fwy #203
   Houston TX 77027
3. About to change in the unpredictably near future; interested people should contact us for current information.
4. Second Friday and fourth Tuesday of each month (unless new meeting place forces a change).
5. *NYBBLE* (at present no articles; just info on meetings and unclassified ads from members)
6. David M Fogg, president
   (713)626-2935
   Clifford Carley, secretary
   (713)921-7532
   Bill Crews, vice president
   (713)353-8798
8. Presently $6 per year (but if we have to start paying for a meeting place . . .)
9. We cover the field; all fields represented.
10. We are convinced that a city the size and modernity of Houston is teeming with people who would like to join a computer club, who aren't even aware of our existence. I sincerely hope this helps to remedy the situation.

1. NASA-JSC Computer Hobbyist Club (Houston TX)
2. Marlow Cassetti
   1011 Devonport Ln
   Seabrook TX 77586
7. (713)474-2923

1. Microputer Tinkers and Bug Busters Society — "Miti BuBus" (Mighty BooBoos)
2. 3845 LeBleu St
   Beaumont TX 77707
3. Here and there at present
6. William (Pete) Peters
7. (713)835-6144
8. At present: one dried turnip, but may be increased very soon
9. Construction projects, software, fun and games programs
10. Interested in receiving newsletters, design data, etc, from other clubs and manufacturers

1. Texas A & M Microcomputer Club
2. POB M-9
   Aggieland Station TX 77844
3. Rm 333B Zachry Engineering Center, A & M University
4. Every other Wednesday
6. Dr Charles Adams
7. (713)823-0877
8. $10 for three semesters (one year, more or less)
9. Everything, but currently many members working on construction of higher level languages for small systems. So far, club projects have been mainly software, although an effort is now being made to start some hardware projects as the club is fortunate enough to have some extremely competent hardware enthusiasts. Games are also very popular, with particular emphasis on Star Trek type games.
10. Meeting so often, we do not currently have a newsletter, although there has been some discussion of initiating one, tentatively titled *The Last Word.* Although we are a university organization, the general public is extremely welcome to attend meetings.

1. Northside Computer Group
2. 2318 Townbreeze
   San Antonio TX 78238
3. Currently same as above
4. Every other Tuesday evening
5. None at present
6. Jim Aldridge
7. Currently no phone
8. No dues
9. 6800 processor oriented, speech synthesis, graphics, interactive higher level languages
10. Newly formed and looking for a permanent meeting place. An Altair 680b is being built up, and a speech synthesizer is presently in the design stage. An ACIA version of MIKBUG is being developed as is a highly graphics oriented Star Trek game.

1. Central Texas Computer Association
2. 508 Blueberry Hill
   Austin TX 78745
3. Old Quarry Branch, Austin Public Library
4. Fourth Monday of every month, 7:30 PM
5. *Print-Out*
6. R D (Ray) McCoy
7. (512)443-0971
8. Dues: $10; annual subscription to newsletter: $6
9. Interests range from the most elementary, to the most sophisticated. (Almost any application that can be dreamed of)

1. El Paso Computer Group
2. 213 Argonaut #27
   El Paso TX 79912

Zips 80000 — 90000

1. Denver Amateur Computer Society
2. POB 6338
   Denver CO 80206
3. First Universal Church
   4101 E Hampden Av
   Denver CO
5. *DACS Newsletter*
6. Jim Clark, editor
   538 S Swadley St
   Denver CO 80228

1. CSPCC (Coeur d'Alene Society for the Prevention of Cruelty to Computers)
2. 205 Foster Apt #2
   Coeur d'Alene ID 83814
3. See #2
4. Each week, Sunday evening
5. None
6. Mark Bentley, president
7. (208)664-6686
8. None yet
9. Our main goals are as follows:
   - Obtain a computer (probably Z-80 based)
   - Create or obtain a Fortran-similar compiler
   - Implement world simulations and war games on said computer

1. Northern Nevada Amateur Computer Club
2. UNSCC
   POB 9068
   Reno NV 89507
3. Washoe County Library
4. Second Wednesday, 7:30 PM or as announced
5. Meeting announcements only, sent to members
6. Al Brady
7. (702)784-4008 or 329-9386
8. None
9. Home hobby systems
10. Organized activities scrupulously avoided; meetings for purpose of information exchange

Zips 90000 — 99999

1. University of California at Los Angeles Computer Club
2. 3514 Boelter Hall
   UCLA Los Angeles CA 90024

1. HP-65 Users Group
2. 2541 W Camden Pl
   Santa Ana CA 90024

1. Cola
2. POB 43677
   Los Angeles CA 90043

1. Beverly Hills High School Computer Club
2. 241 Marino Dr
   Beverly Hills CA 90212
7. (213)277-5900
10. The main purpose of the club is to invite people from the computer industry or from related fields to our campus as guest speakers.

1. Southern California Computer Society
2. POB 987
   South Pasadena CA 91030

1. San Gabriel — Southern California Computer Society
2. Dan Erickson
   400 S Catalina Av
   Pasadena CA 91106

1. Glendale Community College Computer Club
2. VS Lashleu
   1500 N Verdugo Rd
   Glendale CA 91208

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TDL-Z-80, Seals, Cromemco,
Veras, Tarbell, Oliver

Magazines, books, chips,
sockets, connectors, terminals.

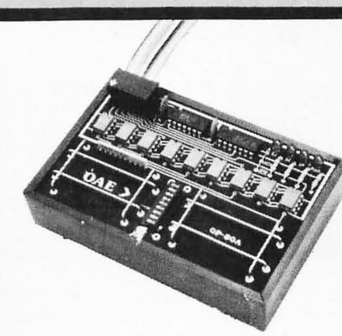
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New York 10001
212–279-1048

Long Island
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East Meadow NY
516–794-0510

AUTHORS WANTED

3¢ plus per word for suitable articles for *Computer Applications* magazine; a new photo-offset publication devoted to personal computing hardware/software, with emphasis on step-by-step how to do it. Full responsibility is assumed for all submissions, both accepted and returned. Write for free details to: *Computer Applications,* 998 Coxwell Ave., Toronto, Ontario, Canada, M4C 3G5 Computer clubs, hobbyists, and commercial advertisers, get on our mailing list. Issue #1 is at the introductory price of only 50¢.



Pictured above is the new OP-80A High Speed Paper Tape Reader from OAE. This unit has no moving parts, will read punched tape as fast as you can pull it through (0-5,000 c.p.s.), and costs **only $74.50 KIT, $95.00 ASSEMBLED & TESTED.** It includes a precision optical sensor array, high speed data buffers, and all required handshake logic to interface with any uP parallel I/O port.

To order, send check or money order (include $2.50 shipping/handling) to Oliver Audio Engineering, 7330 Laurel Canyon Blvd., No. Hollywood, CA 91605, or call our 24 hr. M/C-B/A order line: (213) 874-6463.

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1. Valley Chapter — Southern California Computer Society
2. R Stuart Gibbs
   5652 Lemona Av
   Van Nuys CA 91411

1. San Diego Computer Society
2. POB 9988
   San Diego CA 92109
5. *Personal Systems*

1. 29 Palms California Area Group
2. Wesley Isgrigg
   74055 Casita Dr
   29 Palms CA 92277

1. North Orange County Computer Club (NOCCC)
2. POB 3603
   Orange CA 92665
3. Administration Building, California State University, Fullerton
4. We usually meet in the afternoon of the first Sunday of the month.
5. *North Orange County Computer Club Newsletter*
6. Lorin Mohler, president
7. (714)998-5831
8. $6 annually, includes newsletters; family memberships will be available.
9. The club is actively acquiring software for 8080 and 6800 microprocessors.
10. NOCCC would enjoy swapping newsletters with other computer oriented groups. We are particularly interested in using our hardware in educational applications and some games. Ideas for successful fund raising are also appreciated.

1. Technological Developments
2. POB 2151
   Oxnard CA 93034
5. *Calculator Lib*
6. Gene Hegedus
7. (805)486-7191
8. $2 per issue postpaid
9. Published for professionals and amateurs liberated by the calculator from the obnoxious drudgery of arithmetical operations. Covering the full range of commercially available calculators from the $8 models to the $1000 programmable units.
10. Contents: Tips and Trix with arithmetix, games and other programs for programmable and the $8 kind of nonprogrammable calculators; vocabulary, news and other tidbits, all to develop the calculator wizardry of the liberated readers.

1. Ventura County Computer SOCIETY
2. POB 525
   Port Hueneme CA 93041
3. Camarillo Public Library,
   3100 Ponderosa Dr
4. The last Saturday of the month not near a holiday (Nov 20 and Dec 18). We may change this in 1977 but will give you three months notice if we do. Time: 9:30 AM to about noon.

> 1. Name of organization
> 2. Mailing address
> 3. Meeting location
> 4. Meeting algorithm
> 5. Newsletter or publication
> 6. Contact person
> 7. Contact phone number
> 8. Dues or subscription fees
> 9. Special interests
> 10. Other comments

5. *The VCCS Newsletter*
6. Fred Moeckel, (805)982-5852 or Bill Cowley, (805)985-2631 (home), (805)982-4045 (work)
8. Currently $5 per year

1. Santa Barbara Computer Group
2. Glenn A McComb
   210 Barrunca #2
   Santa Barbara CA 93101

1. San Luis Obispo μ-Computer Club
2. 439 B Marsh St
   San Luis Obispo CA 93401
3. Cal Poly State Univ SLO
4. Meetings are first and third Tuesdays of the month at 7 PM
5. No newsletter yet
6. Bob Neeper or Rick Stellmacher
7. (805)544-5441
8. No dues
9. Trading hardware and software, lectures and seminars by members of the club and industry

1. *Micro-8 Newsletter*
2. Cabrillo Computer Center
   4350 Constellation Rd
   Lompoc CA 93436

1. Computer Phreaques United
2. Mac McCormick
   2090 Cross St
   Seaside CA 93955

1. Homebrew Computer Club
2. POB 626
   Mountain View CA 94042
5. *Homebrew Newsletter*
10. The newsletter is sent to anyone on request; however, donations are greatly appreciated for the cost of postage labels and printing.

1. Bay Area Microprocessor's User Group
2. 1211 Santa Clara Av
   Alameda CA 94501
3. The Great Western Savings Building at E 14th and Davis Streets, San Leandro CA, in the community room on the second floor
4. We meet the first Thursday evening of every month at 7 PM.
5. We have no newsletter yet.
6. Timothy O'Hare
7. (415)523-7396
8. Dues are collected only if we need money and are voluntary ($.50).

1. Bay Area Micro Group
2. 4565 Black Av
   Pleasanton CA 94566

1. LLLRA Hobbyist Group
2. Charles D Hoover
   35 W Essen St
   Stockton CA 95204

1. Sacramento Minicomputer Users
2. POB 741
   Citrus Heights CA 95610

1. Computer Guild
2. POB 255232
   Sacramento CA 95825
3. Meetings are held at members homes at present.
4. Meetings scheduled when possible
5. None at present
6. Quentin T Fox Jr, guildmaster
7. (916)489-5400
8. Presently requiring only interest, knowledge and equipment
9. General computing and controller systems development
10. We are very interested in the development of a portable general purpose computer (hand held?), possibly based on the TI SBP0400A 4 bit slice processor.

1. Aloha Computer Club
2. 94-360 Hokuala St Apt 187
   Mililani Town HI 96789
3. Hawaiian Telephone Plant Training School, Bldg A, at end of Kikowaena St, Moanalua
4. First Wednesday of each month at 7:30 PM
5. None yet
6. Donald D Henson
7. (808)623-1781
8. None yet
9. Undefined
10. Alternate contact: Robert Kennedy (808)946-9761

1. Portland Computer Society
2. 1003 Garland St Apt 4
   Woodburn OR 97071
3. Portland Community College, in one of the rooms off of the main cafeteria (Mt Sylvania campus)
4. Third Saturday of the month, 1-4 PM
5. None published as yet, but plans afoot
6. Mike Boyd, The Byte Shop, Portland
   Also Percy G Wood, address see #2
7. Check with directory assistance for the Byte Shop. Else try 981-4985.
8. $10 per year
9. None for the society, but SIGs planned
10. Place to contact is the Byte Shop.

1. Portland Computer Club
2. Bill Marsh
   2814 NE 40th St
   Portland OR 97212

1. Northwest Computer Club
2. POB 5304
   Seattle WA 98105
3. Usually meets at Pacific Science Center (near the math exhibits)
4. First and third Tuesday of the month, at 7 PM
5. *Northwest Computer Club Newsletter (NCCN)*, monthly
6. John Marshall, NCCN editor
   (206)251-5695, work
   (206)226-7775, home
   Steve Patchen, (206)543-1788, work
   (206)364-6447, home
   Bob Wallace, (206)524-6359, 12-2 PM
8. Subscription/dues not set for next year
10. We have about 130 members with 40 microcomputer systems running. Membership is divided about equally between hardware professionals, software professionals, and students.

Canada, New Zealand

1. Montreal Area Computer Society MACS
2. 4100 Kindersley Av Apt 22
   Montreal, Quebec CANADA
3. Vanier College
   5160 Decarie Blvd
   Montreal, Quebec
4. Once a month
5. *The Golden Arches*
6. Leslie Zoltan
7. (514)733-8890
8. $.50 per meeting
9. Computer applications
10. 20 members as of Sept 1 1976; have had two meetings; seeking new members

1. Toronto Region Association of Computer Enthusiasts (TRACE)
2. Harold G Melanson
   POP 545 Streetsville PO
   Mississiagua, Ontario CANADA
   L5M 2C1

1. Amateur Microprocessor Club of Kidchener-Waterloo
2. Reading Room
   Electrical Engineering
   University of Waterloo
   Waterloo, Ontario CANADA N2L 3G1
6. Charles Sooley or C Ed Spike
7. (519)885-1211

1. Canadian Computer Club
2. 861 11th St
   Brandon, Manitoba CANADA R7A 4L1
6. (204)725-1079

1. INFO FILE
2. POB 27-206 B
   Mt Roskill
   Aukland NEW ZEALAND ■

BYTE's Bits

A Business Services Time Sharing Service

Quikdata is the name of an outfit which makes available large scale processing facilities and debugged business software which can be accessed via a small computer system lacking extensive mass storage, debugged software or number crunching capability. The service operates in a remote batch mode at 110, 300 and 1200 baud over the telephone network. It requires that the user's computer be equipped with an originate modem, BASIC language with IO control for cassette or floppy disk, and the floppy disk or cassette. (Any other electronically controlled medium to high speed mass storage device could be used.)

Write for a free brochure which describes the software which is available on a time sharing system, along with latest user manuals, computer assisted instruction programs, a high level language for report generation, translators for BASIC and various assembler dialects, and a software exchange with 30% royalties for the authors.

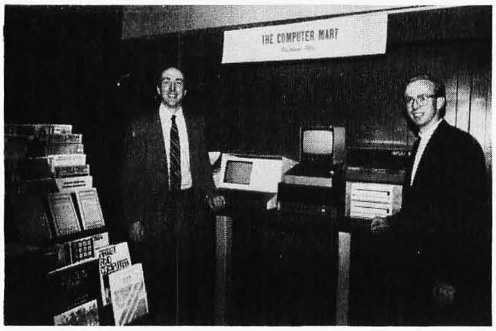
According to the brochure, the service of Quikdata is created by Dr Ernst J Schubert, an applied physicist and electrical engineer with extensive past experience in computer design starting at Westinghouse, Burroughs, Beckman Systems, and later business and consulting experience in economic modeling, production and inventory control software, etc. To find out what Quikdata can do for your business or professional activities with a microcomputer system, write Dr Schubert and Company at Quikdata, 3431 Cerritos Av, Los Alamitos CA 90720.■

Consumer Notes. . . Collectors Items

We notice that several sources lately have been trying to remanufacture collector's items. Readers should be aware of what it

takes to make such items, based upon our experiences here at BYTE. A collector's item must be rare, it must have quality, it must have a very limited supply, and above all, it must have a market. We have considerable experiences with collector's items around BYTE, and believe we know one when we see one. For example, a carved jade fish in the Huang style from the Shang period in China, circa 1766-1121 BC, in good condition, is a collector's item. A Baccarat paperweight with signature cane for 1848 in beautiful condition is a collector's item. A Steinway 1910 baby grand player piano in mint condition is a collector's item. The Joseph Henry signalling key pictured on the front of October's BYTE is also a collector's item. All of these are examples of collector's items. None of the above were manufactured with a thought in advance that they would become collector's items.■

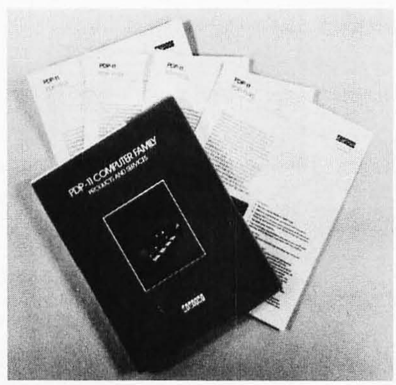
**Your Friendly Computer Store . . .
The American Dream**



Here is a view of another example of the movement toward local computer stores. This is a photo supplied by Dr Charles Dunning (left) owner of the Computer Mart of Waltham MA, and his partner John Dunning. The photo marks the opening of the store (officially) on October 14 1976, located at 1097 Lexington St, Waltham MA and open from 11 AM to 8 PM, Tuesday through Friday; Saturday 11 AM to 5 PM. The store carries four computer lines: IMS Associates, Southwest Technical Products, Digital Group and Sphere.■

Wonder About PDP-11s?

Digital Equipment Corp has just published a marketing brochure entitled "PDP-11 Computer Family Products and Services," pictured here. PDP-11 products range in size and power from the packaged LSI-11 called a PDP-11/03 to the medium scale general purpose computer system which is the PDP-11/70. For your copy, write to Communications Services, Digital Equipment Corp, 444 Whitney St, Northboro MA 01532.■



APL NEWS

APL Enthusiasts Take Note

APL Press is a new publishing house devoted exclusively to APL material. Seven titles are currently available, and further manuscripts are being sought. A newsletter is issued periodically, containing brief articles, reports on conferences, book reviews, problems, correspondence, and other items of interest to the APL community. Readers interested in receiving the newsletters and book lists, or in submitting material for publication, should write to APL Press, POB 27, Swarthmore PA 19081.■

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TERMS: Add 50¢ handling to orders under $10. Cal res add tax. No COD; to place BankAmericard® or Mastercharge® orders, call **(415) 562-0636**, 24 hours.

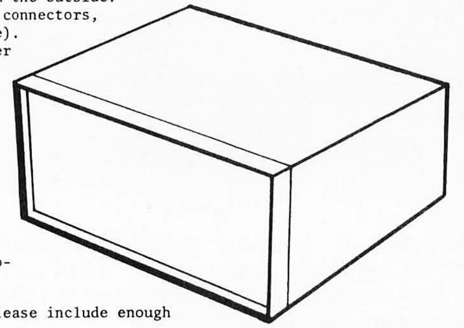
OUR FLYER HAS IT!

If you want to see the latest in interesting goodies for computer hobbyists, ask for our current flyer. It has Altair/IMSAI etc compatible peripherals; some of the newest octal parts, a complete line of TTL, CMOS, and Low Power Schottky ICs; power supplies; connectors; enclosures; and all the capacitors & resistors you could ever want, as well as a full line of Vector products---SEND FOR OUR FLYER!!

HAPPY NEW YEAR

NEW! Enclosures from VECTOR

Deluxe cases that look beautiful---no screws or fasteners mar the good looks from the outside. Interior slots hold card guides, connectors, etc. (not included with enclosure). All enclosures available in either dark blue or black with white front panel. Order from the following---



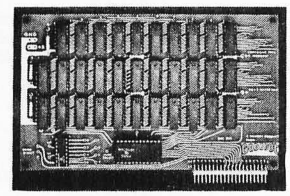
#VP5-17-17U: 5.51" H, 17.58" W, 17.1" D. **$79.25**

#VP7-17-17U: 7.26" H, 17.58" W, 17.1" D. **$84.00**

#VP9-17-21U: 9.01" H, 17.58" W, 21.6" D. This is exactly the same size as the IMSAI 8080 microcomputer. **$96.50**

All units shipped unassembled; please include enough for postage (excess refunded).

BASIC RAM $88



This 4K by 8 memory board has no frills, just storage. Designed for compatibility with JOLT systems, this board is also ideal for other microcomputers using bi-directional buss systems. Same size as JOLT memory card, plus lo-power operation (1.3Amax) to keep you on good terms with your power supply.

If you don't need the onboard regulation or address / data buffers of our "Bigger Brother" 4K board, then this is the way to go.

Sockets included for all ICs.

9601

FACTORY FRESH PRECISION ONE-SHOT 4/$1
FACTORY FRESH PRECISION ONE-SHOT 4/$1
FACTORY FRESH PRECISION ONE-SHOT 4/$1

ECONORAM™ in kit form $99.95

We took everything we learned from selling 4K x 8 RAM boards for the past year, added some of this year's circuit tricks, and came up with ECONORAM --- a memory board that is even more remarkable due to its low price. We've engineered this with the user in mind, giving you several benefits:

* 3 regulators to share power load, plus optimized thermal design, means a cooler running microcomputer
* Typical current consumption of under 750 ma gives your power supply a break
* Fast --- Zero wait states
* All TTL support ICs are latest Low Power Schottky types
* For reliable and unambiguous data transfer, all addresses, data lines, and outputs are buffered for minimum loading and maximum output capability
* Power-on clear included

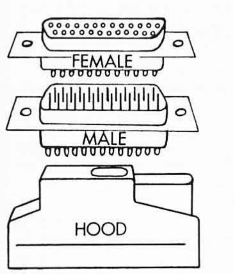
All these features are packed on to an Altair-sized, industrial quality double-sided PC board, with sockets for all ICs, 7 tantalum capacitors for power supply decoupling, and plenty of by-pass capacitors---39 of them, in fact, as well as a logic print and instructions.

also available assembled $129.95

Our popular **ECONORAM 4K x 8 RAM** board is now available **assembled, tested, and warranteed for one year.** Plug it in to your Altair or IMSAI and enjoy the same performance that has made the kit such a success---guaranteed zero wait states and current drain of 750 mA or less; on board regulation, easy address selection, and lots more.

Submini "D" Connectors!

MALE WITH HOOD $3.95; FEMALE CONNECTOR $3.95.



lo profile sockets

HERE'S YOUR CHANCE TO BUY SOME TOP QUALITY SOLDERTAIL SOCKETS AT THE RIGHT PRICE.

	16 PIN...10/$2.15
14 PIN...10/$1.95	20 PIN...10/$3.10
22 PIN...10/$3.50	24 PIN...10/$3.60
36 PIN...10/$5.50	40 PIN...10/$6.15

LTD QTY SPECIAL: 18 Pin 8/$1.50

COOL MEMORY

DISCOUNT: Buy 10, take 10% Buy 100, take 20%.

We just got a batch of **low power** and **fast** (450 ns maximum--full temp range) 2102L1 static RAMs. Perfect for memory boards--and at our usual reasonable price: **$1.95!**

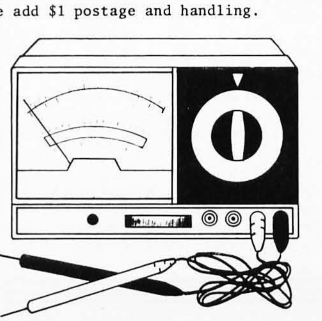
CHIP SET $36.95

1-8080A, 1-8224, 1-8212, AND AN 18 MHZ CRYSTAL AT A SAVINGS OVER INDIVIDUAL PRICES: FORMS THE CORE OF A QUALITY 8080A CPU BOARD.

Multi Meter $14.99

An outstanding buy...6 DC Volt ranges, 3 DC current, 5 AC Volts, 2 ohms, and dB scale too. 50 uA movement; plus "off" position damps meter for safe transportation. Includes 34 inch test leads but less 1 AA battery. Small--a compact 5¼" x 3¼" x 1 5/8".

Please add $1 postage and handling.



.01% ACCURACY IN A TO-5 CAN...not just useful for fixed frequency oscillators, since most numbers can be used with simple binary dividers to generate other frequencies.

For example, 15.360 can divide down to 60 Hz for timing pulse purposes:

16.384 divided by 2^{14} gives 1 Hz timing pulses; and so on. All frequencies $4.95 --- apply IC discount schedule for quantities. ALL FREQUENCIES IN KHz.

STATEK CRYSTALS

Choose from:

10.000	12.800	15.360
16.000	16.384	
18.641	19.200	20.480
		30.720
31.500	32.768	
38.400	40.960	60.000
76.800	100.00	153.60
	240.00	

CRYSTALS

SENTRY CRYSTALS-- $4.95 PER CRYSTAL

Series mode, fundamental, wire leads, for hams and computer bugs. Choose from 4 MHz (PACE clock crystal), 5 MHz 8 MHz, 10 MHz, 12 MHz, 15 MHz, 18 MHz (8080 clock crystal), and 20 MHz.

"EconoRom" $179.95

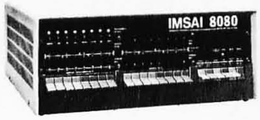
ALTAIR 8800/IMSAI PLUG-IN COMPATIBLE. This is a 4K by 8 EROM board...the ideal place for putting software, be it assembler, editor, or any custom set of routines. Additionally, this board may expand to 8K x 8 by simply adding more sockets and EROMs; also available is a 2K x 8 version if you don't need a full 4K. LOW POWER: 8K board requires ½A @ 5V, & 150 ma @ -12V. Buffered addresses for lightest loading, buffered outputs for maximum drive. Kit includes sockets, double-sided quality PC board, on board regulators, logic print, and instructions. Program it yourself, or have us do the programing.

8K X 8 BOARD $269.95 **2K X 8 BOARD $135.00**

8080 Software Board $189.95

We took our ECONOROM board kit, but instead of including blank EROMs, these are programmed with assembler, editor, & monitor routines for the 8080. This is a valuable first step if you're trying to get away from machine language programing. There's not really enough room here to fully describe all the functions of the software...but if you send us **$2.95** (refundable with order), we'll send you our software packet that includes instructions listing, schematic, and assembly data.

from
proko!!



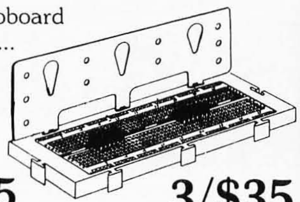
IMSAI 8080: $550

The "Heavy Duty" Computer. Altair compatible so you can use all of the inexpensive memory cards. For 22 slot Mother Board Add $45

IMSAI's new I/0 board $185

* 2 parallel ports
* 1 serial port
* cassette interface
* control port

The prokoboard from BIM...

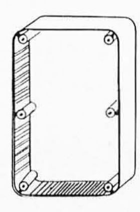


$14

2/$25 **3/$35**

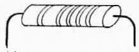
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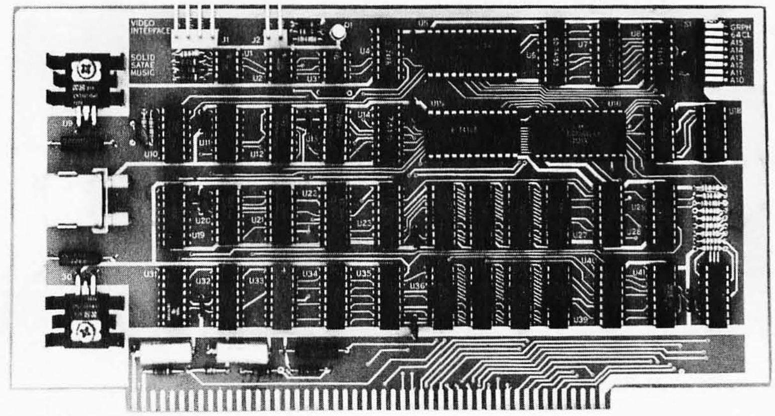
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MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM6316	4 Digit, Alarm, 1 PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.95

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
Linear	Pin-out & Functional Description	$2.95

ALL THREE HANDBOOKS $6.95

FAIRCHILD TECHNOLOGY KITS FAIRCHILD



- Complete Specifications on back of each kit
- Packaged for WALL DISPLAY APPEARANCE
- Dealer's Inquires Invited — Price List Available



DIGITS

FTK0001	0.5" High Common Cathode Digit	$1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	.357" High Common Cathode Digit	.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

LED LAMPS

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

PHOTO TRANSISTORS

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTO ARRAYS

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12-Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

COUPLERS

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

MOS CLOCK CIRCUITS

FTK0400	Digital Clock/Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock/Calendar Circuit (FCM7015)	6.00

KITS

FTK0106	Automobile Clock Kit	40.00

DISCRETE LEDS



.125" dia.			.90" dia.		
XC209	Red	10/$1	XC111	Red	10/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
			XC111	Orange	4/$1

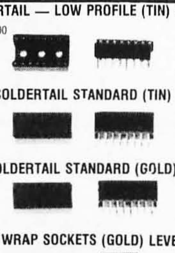
.200" dia			.185" dia.			.200" dia.			.085" dia.
XC22	Red	10/$1	XC526	Red	10/$1	XC556	Red	10/$1	MV50
XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	7/$1	.085" dia. Micro
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	7/$1	red LED
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	7/$1	6/$1
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1	

DISPLAY LEDS

DL707   DL33B

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	.270	2.95	MAN 3620	Common Anode-orange	.300	1.75
MAN 2	5 x 7 Dot Matrix	.300	4.95	MAN 3640	Common Cathode-orange	.300	1.75
MAN 3	Common Cathode	.125	.39	MAN 4710	Common Anode-Red	.400	1.95
MAN 4	Common Cathode	.187	1.95	DL701	Common Anode-red ±	.300	.99
MAN 7	Common Anode	.300	1.25	DL704	Common Cathode	.300	.99
MAN 7G	Common Anode-green	.300	1.95	DL707	Common Anode	.300	.99
MAN 7Y	Common Anode-yellow	.300	1.95	DL 728	Common Cathode	.500	1.95
MAN 52	Common Anode-green	.300	1.75	DL 747	Common Anode	.600	2.25
MAN 64	Common Anode-red	.400	1.75	DL 750	Common Cathode	.600	2.49
MAN 72	Common Anode	.300	1.25	DL 33B	Common Cathode	.110	.50
MAN 74	Common Cathode	.300	1.50	FND70	Common Cathode	.250	.75
MAN 82	Common Anode-yellow	.300	1.75	FND503	Common Cathode	.500	1.00
MAN 84	Common Cathode-yellow	.300	1.75	FND507	Common Anode	.500	1.00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS



	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.37	.36	.35				

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	.25	.24	28 pin	$ .99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$ .70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

WIRE WRAP TOOL

Part Number WSU-30 **$5.95 ea.**

(FOR 30 AWG WIRE)



WIRE WRAP WIRE

30 AWG — 25 ft. min. - $2.10   50 ft. - $2.75   100 ft. - $3.50   1000 ft. - $24.00

SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5%	50 PCS.
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5%	50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5%	50 PCS.
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	1/4 WATT 5%	50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

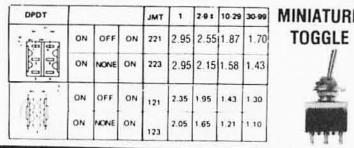
Spec Sheets - 25¢ — Send 24¢ Stamp for 1977 Catalog
Dealer Discount Available — Request Pricing

NOW OPEN SATURDAYS

James ELECTRONICS

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru January

MINIATURE TOGGLE



DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	2.95	2.55	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.65	1.21	1.10

PUSH BUTTON

SPDT – SERIES PB, PB1

Maintained Action Switch — Push To Make Contact And Push Again To Reserve Action: **PB-123 $1.75**

Momentary Action Switch — Normally Open or Normally Closed (For N.C circuit use terminals 2 & 1; for N.O. 2 & 3; for N.C and N.O. 1,2,&3): **PB-126 $1.75**

5 AMP RATINGS



THUMBWHEEL SWITCHES

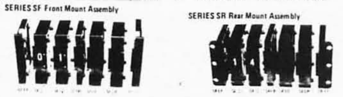
THUMBWHEEL SWITCH ONLY

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21		3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF – Front Mount   SR – Rear Mount

SERIES SF Front Mount Assembly   SERIES SR Rear Mount Assembly



ACCESSORIES

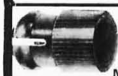
Part No.	Description	Price	Part No.	Description	Price
SF EP	End Plate (Pair)	.50	SR EP	End Plates (pair)	$ .50
SF DP	Divider Plate (each)	.40	SR DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40	SR BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40	SR HB	Half Body (each)	.40

DIP SWITCH



These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. **$1.95**

CLIPLITE !! 4/$1.00



NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the Panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDS.
- CLIPLITE is to be used with XC556 LEDS.
- Specify colors—red, green, amber, or yellow when ordering.

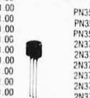
ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	.28
1N5234	6.2	500m	28	1N4735	6.2	1w	.28
1N5235	6.8	500m	28	1N4736	6.8	1w	.28
1N5236	7.5	500m	28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	25A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS



MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00	PN3567	3/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3568	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3569	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3707	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3724	$ .65	2N5088	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3055	$ .89	2N3905	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5951	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00	2N4123	10/$1.00	2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

XR-2260KB Kit $27.95 **XR-2206KA Kit $17.95**

EXAR

WAVEFORM GENERATORS		MISCELLANEOUS		TIMERS	
XR-205	$8.40	XR-2211CP	$6.70	XR-555CP	$ .49
XR-2206CP	4.49	XR-4136	.99	XR-320P	1.55
XR-2207CP	3.85	XR-1468	3.85	XR-556CP	1.85
STEREO DECODERS		XR-1488	5.80	XR-2556CP	3.20
XR-1310CP	$3.20	XR-1489	4.80	XR-2240CP	3.25
XR-1310EP	3.20	XR-2208	5.20	**PHASE LOCKED LOOPS**	
XR-1800P	3.20			XR-210	5.20
XR-2567	2.99			XR-215	6.60
				XR-567CP	1.95
				XR-567CT	1.70

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95

25 PIN-D SUBMINIATURE

DB25Plug	$3.25
DB25Socket	$4.95

iMC 3½ DIGIT DVM KIT



This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case $49.95
B. 5V Power Supply $14.95

VECTOR WIRING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$9.95**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg. 3	250 ft. 36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft. 36 AWG RED	$2.40
W36-3-C-Pkg. 3	250 ft. 36 AWG CLEAR	$2.40
W36-3-D-Pkg. 3	250 ft. 36 AWG BLUE	$2.40

1/16 VECTOR BOARD

0.1" Hole Spacing, P-Pattern

	Part No.	L	W	Price 1	Price 2-Up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

HEAT SINKS

205-CB	Beryllium Copper Heat Sink with Black Finish for TO-5	$ .25
291-.36H	Aluminum Heat Sink for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum Heat Sink for TO-3	$1.60

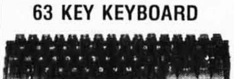
HEXADECIMAL ENCODER 19-KEY PAD



- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

63 KEY KEYBOARD

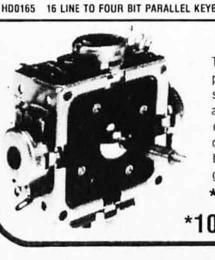


This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications.

$19.95

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four * potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

***5K Pots $6.95**
***100K Pots $7.95**

MICROPROCESSOR COMPONENTS

8080 SUPPORT DEVICES

8080A $29.95 — **8080 $24.95**

8212	8 BIT INPUT/OUTPUT PORT FOR 8080	$ 4.95
8216	NON INTERRUPT BI-DIRECTIONAL BUS DRIVER	6.95
8224	CLOCK GENERATOR AND DRIVER FOR 8080	12.95
8228	SYSTEM CONTROLLER AND BUS DRIVER FOR 8080	12.95

CPU'S			**RAM'S**			
8008	8 BIT CPU	$19.95	1101	256 x 1	Static	$ 2.25
8080	Super 8008	24.95	1103	1024 x 1	Dynamic	1.00
8080A	Super 8008	34.95	2101	256 x 4	Static	5.95
SR'S			2102	1024 x 1	Static	1.75
2504	1024 Dynamic	$ 9.00	2107	4096 x 1	Dynamic	9.95
2518	Hex 32 BIT	7.00	2111	256 x 4	Static	6.95
2519	Hex 40 BIT	4.00	7010	1024 x 1	MNOS	29.95
2524	512 Dynamic	2.49	7489	16 x 4	Static	2.49
2525	1024 Dynamic	6.00	8101	256 x 4	Static	6.95
2527	Dual 256 BIT	3.95	8111	256 x 4	Static	6.95
2529	Dual 512 BIT	4.00	8599	16 x 4	Static	3.49
2532	Quad 80 BIT	3.95	91L02	1024 x 1	Static	2.25
2533	1024 Static	7.95	74200	256 x 1	Static	6.95
3341	Fifo	6.95	93421	256 x 1	Static	2.95
74LS670	16 x 4 Reg	3.95	MM5262	2K x 1	Dynamic	.99
UART'S			**PROMS**			
AY-5-1013	30K Baud	$5.95	1702A	2048	Famos	$12.95
ROM'S			5203	2048	Famos	14.95
2513	Char. Gen.	$ 9.95	82S23	32 x 8	Open C	5.00
2516	Char. Gen.	10.95	82S123	32 x 8	Tristate	5.00
74S387	1024-Bit Programmable	1.95	74S287	1024	Static	7.95
			3601	256 x 4	Fast	3.95

BIPOLAR PROM SPECIAL

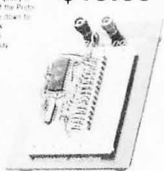
6330-1	256 Bit (32 x 8) Open Collector	2.95	6306-1	2048 Bit (512 x 4) Three State	9.95
6331-1	256 Bit (32 x 8) Three State	2.95	6340-1	2048 Bit (512 x 8) Open Collector	19.95
6300-1	1024 Bit (256 x 4) Open Collector	3.49	6341-1	2048 Bit (512 x 8) Three State	19.95
6301-1	1024 Bit (256 x 4) Three State	3.49	6352-1	4096 Bit (102 x 4) Open Collector	19.95
6305-1	2048 Bit (512 x 4) Open Collector	9.95	6353-1	4096 Bit (1024 x 4) Three State	19.95

Continental Specialties

Proto Board 100 $19.95

THE MINI-BREADBOARD BUDGET KIT

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto Board series ... complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets, 1 QT-35B Bus Strip, 2 5-way binding posts, 4 rubber feet, screws, nuts, bolts and easy assembly instructions.



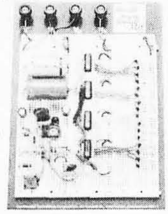
Proto Board 101 Compact, inexpensive 10 14-pin DIP capacity 5.8" long x 4.5" wide **29.95**

Proto Board 102 Compact 12 14-pin DIP capacity 7" x 4½" **39.95**

Proto Board 103 2,250 solderless tie points (4) 5-way binding posts. 24 14-pin DIP capacity 9" x 6" **59.95**

Proto Board 104 Huge 3,060 solderless tie points (4) 5-way binding posts 32 14-pin DIP capacity 9½" long x 8" wide **79.95**

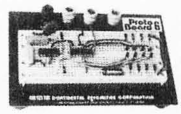
COMPLETE KIT



DESIGN MATE 1

CIRCUIT DESIGNER
You asked for it. HERE IT IS! CSC's basic circuit designer to help you build and test ANY electronic circuit. Solid #22 AWG wire interconnects any discreet component without solder. Resistors, Transistors, Linear Digital ICs in TO-5 DIP packages (from 8-40 pins). And more. Components fit directly into Sockets and Bus strips instantly and easily. Plus DESIGN MATE ONE's (DM-1) variable regulated power supply gives 5-15VDC up to 600ma (9 watts). Now that's design flexibility for you!
You can even monitor the DM-1's internal power supply or external circuits thanks to the built-in 0-15V voltmeter. If you're into electronics, DM-1 is a must for your laboratory. It comes to you completely wired, tested and ready to use for only **$54.95**





PROTO BOARD 6
The PB-6 lets the user test and build circuits without soldering or patch cords ... all interconnections between components are made with common #22 AWG hook up wire. This quality breadboarding kit includes 630 component tie points at less than 2.5 cents each. It measures 6" long by 4" wide. Designed specially to Breadboard Microprocessor Circuits.

Proto Board 6 $15.95

Now trace signals or troubleshoot fast. Inject signals or wire unused circuits into existing boards. Scope probes, test leads lock onto Dynagrip inset. Plastic construction — no springs or pivots. Thousands of operations. Narrow throat for high density PC boards.

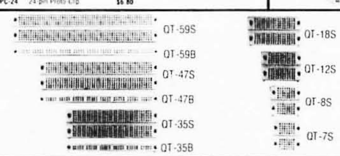
PC-14	14-pin Proto Clip	$3.60 ea
PC-16	16-pin Proto-Clip	$3.80
PC-24	24-pin Proto Clip	$6.80



SPECIAL!



LOGIC MONITOR
Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs.
Pocket size. **$84.95.**



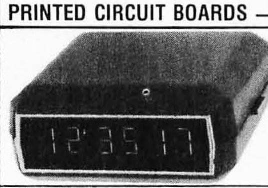
QT Proto Strips

QT type	#holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

Grab Bag Specials

CAPACITORS — 100 ea. Ceramic Disc	$2.00/lot	RESISTORS — 40 ea. wire-wound 3-10 W/.1-100 ohm	$5.50/lot
CAPACITORS — 60 ea. Mylar	4.00/lot	RESISTORS — 40 ea. wire wound 3-10 W/100-25K	5.00/lot
CAPACITORS — 60 ea. Electrolytics	4.00/lot	SWITCHES — 12 ea. Micro Switches	3.00/lot
CAPACITORS — 40 ea. Dipped Tantalum	4.00/lot	SWITCHES — 25 Miniature Slide	3.00/lot
DELAY LINE — 10 ea.	3.00/lot	SWITCHES — 12 each Rocker	3.00/lot
DIODES — 100 ea. Germanium	2.00/lot	SWITCHES — 20 ea. Reed-Coil & Magnetics	5.00/lot
DIODES — 100 ea. Rectifiers Silicon	2.00/lot	THERMISTORS — 20 ea.	3.00/lot
DIODES — 100 ea. Silicon	2.00/lot	TRIMMERS — 40 ea. Miniature	4.00/lot
IC's — 100 ea. Unmarked or House #	4.00/lot	TRANSISTORS — 100 ea. Plastic & Power	3.00/lot
LEDS — 100 ea. Asst. Sizes & Colors	5.00/lot	TUBING, SHRINK — 30 pcs. 6" Asst. Sizes & Colors	4.00/lot
LAMPS NEON — 40 ea. NE2 Type	3.00/lot		
POTENTIOMETERS — 10 pcs. P.C. Mount. Asst.	4.00/lot		
RESISTORS — 100 ea. Values & Wattages	1.00/lot		

PRINTED CIRCUIT BOARDS — Min. 50 ea. Various Components $2.00 each



DIGITAL QUARTZ CAR CLOCK

Complete kit from mounting bracket of the injection molded case down to the three conductor power cord and all components including MM5314 clock chip. Features quartz accuracy of .01%, six digit, .35" high LED display, and P.C. Boards. Works on any 12 volt system — motorcycles, boats, vans, motorhomes, autos, and trucks.

DIMENSIONS: 4½" x 4" x 2" — 12 OR 24 HOUR MODE.

Kit: $29.95 Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) **$5.95**

DIGITAL CLOCK KIT — 3½ INCH DIGITS



This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½", and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer.

Specify 12 Or 24 Hr. When Ordering

4 DIGIT KIT $49.95 **4 DIGIT ASSEMBLED $59.95**
6 DIGIT KIT $69.95 **6 DIGIT ASSEMBLED $79.95**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax
Spec Sheets - 25¢ — Send 24¢ Stamp for 1977 Catalog
Dealer Discount Available — Request Pricing

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James ELECTRONICS

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru January

PONG

PONG SINGLE GAME **$55.00**

SUPER PONG 4 GAMES IN ONE **$79.95**
(Pong, Super Pong, Catch, Handball)



- Incremental speed on volleys increases excitement.
- Game appears in color or in balck & white, depending on television set.
- Digital scoring flashes on the screen between each point.
- Hooks up simply to any model television set; the screen actually becomes the playing field.
- Battery operated by 4 size "D" flashlight batteries included with the Unit.

AC Adaptor (Eliminates Batteries) **$9.95**

DIGITAL WATCHES



Ladies Watch
- 6 Function
- Bracelet Styling
- 1 Year Guarantee
- Model 900
- Specify Gold or Chrome

$69.95

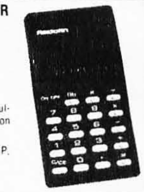
EXELAR Mens Watch
- 5 Function
- Quartz Crystal
- Black Leather Band
- Manufacturer Guarantee
- Specify Gold or Chrome

$29.95

5 FUNCTION ELECTRONIC CALCULATOR

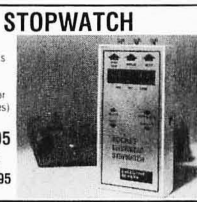
RADOFIN MODEL 8P

$8.95



FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 1 piece 9V DC Battery, UGP jack for AC adapter
- Black superfine grained finish plastic cabinet

DIGITAL STOPWATCH

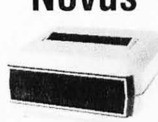


- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells.

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

DIGITAL ALARM CLOCK

Novus



This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.

$19.95 **NOT A KIT**

JE700 CLOCK

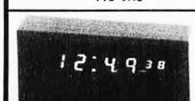


12 or 24 Hour

115 VAC

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

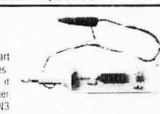
$17.95



This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

JE803 PROBE



The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1 (LOW) - o (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

± 5 VOLT POWER SUPPLY

$39.95

Completely Assembled
- +5 Volts @ 6 Amps Regulated Output
- −5 Volts @ 6 Amps Regulated Input
- 6.3Volts @ 5 Amps Unregulated Output

Length 8⅝" x Width 6½" x Height 4"



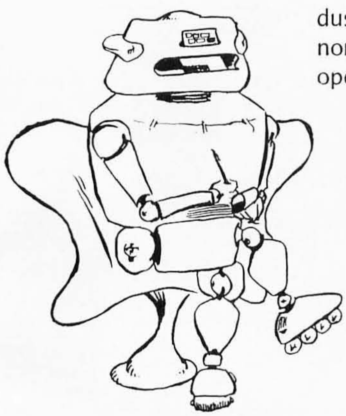
Limited Supply

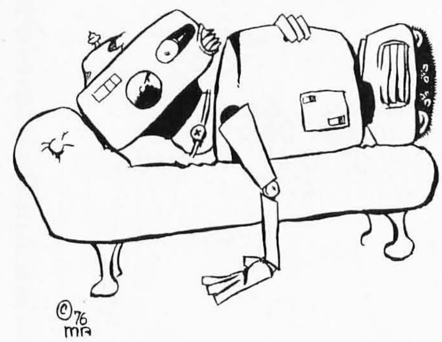
Ask BYTE

Help! I Want Robots

I am not sure where to start my plea. I hope I don't sound too negative when I say I'm not sure if you can help me. The unsureness is based on trying to get information on a growing (?) but frustrating interest of mine and that is robotics. Looking at the front cover of BYTE #12 has my hopes up a small amount.

First of all I am not interested in industrial robots of the assembly line variety, nor robots that are controlled by a human operator at a remote position. My interest





instead lies on self-navigating self-contained robots *[shades of Asimov!]* that function with their own feedback devices with their "intelligence" on board. I realize the "state of the art" of this type of robot is not too sophisticated as of this time. However, until I started my own search for information on this area I did not realize how destitute of information the field was. The information pool at the amateur level is dry. *[It should be — no nonamateur has yet built one either.]* It took me two to three months of intensive searching to even begin to dig up a few stray pieces of information. One thing I turned up was and still is above my head (although I'm working on it) and that is a pair of books by John F Young, one called *Robotics* and another called *Cybernetic Engineering.*

To further add to my frustrations I see advertisements such as found in your magazine that allude to the use of products in robotics. For example the Cromemco advertisement in BYTE #11. That ad shows a D-A converter with box diagram inputs and outputs with one of the outputs labelled "robots." Did they throw this in for the fun of it or are they honestly aware of actual robotic applications along these lines? The article in BYTE #12,"Friends, Humans and Countryrobots . . . " once again implies the use of currently available products in robotics. Other magazines have implied similar things in past issues.

What I need to know is:1) Are there any amateur clubs in existence in the field of robotics? 2) Do any companies exist that sell kits of possibly a rudimentary robot or even a plastic model usable for serious robotics? 3) Are there any plans in existence that would discuss the building of a robot on a "serious" level? 4) Are there any books on the amateur or hobby level on robotics? Or, as a last resort 5) is there in existence a nifty technical looking multicolor poster that I could hang on the wall and dream the impossible dream about?

Dean Blondefield
24383 Park St
Hayward CA 94544

Wow!

Who knows where to begin, but here are some (not necessarily complete) answers to a few of your points, last in first out: 5) For posters, look up some science fiction magazines at your local newstand; several such magazines sell posters taken from covers. 4) Not that we know about. 3) Not any current plans using microcomputers and AI techniques, though wait a few years and there should be some. 2) No (let the company which does prove us wrong by protesting). 1) Unknown to us. Maybe you should start one.

Now that the explicit question stack is popped, some general comments: In order to build robots, you need digitally controlled feedback networks (programs plus peripherals) to position the arms, legs, what have you, based upon sensor data. The Cromemco D-A card could indeed be used as a key element in that process. But there are two key problems in making robots: One is the mechanical one of making a responsive and reliable mechanical system for locomotion and manipulation of objects; this is not too insurmountable; the second one is what all the AI people have been spending years upon, the problem of building and debugging the software needed for pattern recognition, decision making and learning in automata, then deciding just what will be the general operations and coding to put into the robot's computer memory. The best tactic for you as a person interested in finding out about what is known is to concentrate upon the "artificial intelligence" branch of computer science, since the major problems are not mechanical but figuring out what to tell the mechanical parts of the robot to do. There is no trite and easy answer to the problem of designing the humanoid robot; the stage we're at now is very primitive technology compared to the robot technology of science fiction romances. ■

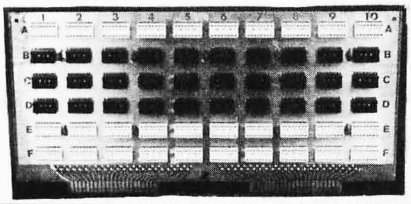
Some letters to BYTE are technical in nature and are best served by some form of response. We will try to answer as many such letters as possible. If you have a puzzle concerning some aspect of the personal computing field, write down a clear statement of your question and send it to:

Ask BYTE
Byte Publications Inc
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Peterborough NH 03458.

We will publish names and addresses of individuals making inquiries unless you specifically request us to omit the reference. ■

DELTA ELECTRONICS

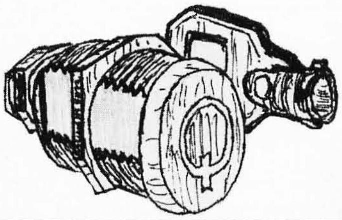
POST OFFICE BOX 2, AMESBURY, MASSACHUSETTS 01913 Phone (617) 388-4705



60 SOCKET PROTOTYPE BOARD

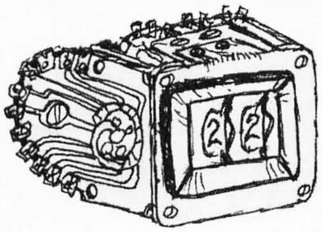
This prototype board, removed from equipment, cost the original user over $200.00 it contains a total of 60 14 and 16 pin gold plated wire wrap IC sockets. Ideal for design work. The board is 5½"x11", and has 2 standard sets of contacts for edge connectors.Contains many .01 caps for by-passing. You do have to remove the original wire wrap on the reverse side. Quantity strictly limited.
STOCK NO.B6434 $29.50 ea. 2/57.00

EQUIPMENT SAFTEY LOCK



This almost completely burglar and tamper proof lock is ideal for your electronic equipment protection. The keys are fluted cylinders, that can only be duplicated by the manufacturer, when properly authorized. Fits any panel from 1/16" to 3/4". Mounting hole is 3/4". A ¼-20 shank on the lock will hold any arm to activate a micro switch.

STOCK NO.B5469 $3.00 per set (1 lock, 2 keys) 2 sets $5.00



DUAL THUMBWHEEL SWITCH

This 2 wheel Thumb Wheel switch counts up to 29 as is. By removal of a small pin it will count up to 99. Each wheel operates a 2 pole ten position switch. Mounts in 4 holes. 1 9/16" apart. All switch leads are gold plated.

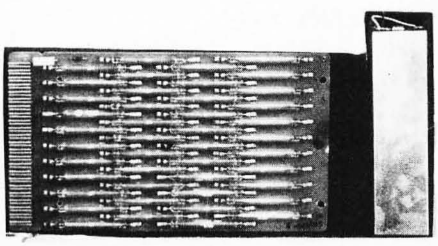
STOCK NO.B6467 $3.50 ea. 2/6.00

4.000000 MHZ PRECISION CLOCK or TIMING CRYSTAL



4.000000 Mhz Crystal. Ideal for computer timing circuits, or as a time base fordigital clocks and gating circuits.

STOCK NO.B1001 CR-18 A/U 4.000000 Mhz. Crystal 3.95 2/7.00



44 POLE REED SWITCH

This unusual circuit board contains 44 single pole, normaly open G.E. reed relays. The relays are in 4 banks of 11 each. They are activated by the elongated coil, (to right of photo), which when 12 VDC is applied, closes the contacts on 11 of the reeds. Four coils are supplied, and 1 or any of them may be activated at one time. Thus it is possible to use any or all banks of reed at one time. We supply 1 44 reed board, 4 coils, and an edge connector in each set.

STOCK NO.B5468 1 set $12.50 2 sets $24.00

SPECTROL MINIATURE PC MOUNT ROTARY SWITCHES

Miniature printed circuit board rotary switches are just about impossible to find on the surplus market. We have been fortunate in locating 3 different numbers, made by SPECTROL, and are still current distributor items. SPECTROL 87-22-25 is a 2 pole 5 position PC mount switch either thumbwheel or screw driver operated. SPECTROL 87-21-19 is a 1 pole 9 position thumb wheel or screw driver operated switch. SPECTROL 87-12-10 is a 1 pole 11 position screw driver operated miniature PC mount switch. All above switches are approx. ½" diam. and ¼" high.



B1005



B1004
B1006

STOCK NO.B1004 2 pole 5 Pos. $2.00 ea. 4/7.00. StocK No.B1005 1 Pole 10 Pos. 1.75 2/3.00
STOCK NO.B1006 1 Pole 9 positions $2.00 ea. 4/7.00 Limited Quantities on all switches

FERRO–RESONANT POWER TRANSFORMERS

These transformers are Ferro-Resonant, and price includes the regulating capacitor. Both made by TRIAD UTRAD

STOCK NO.B6436 has 4 windings and an isolation winding. Winding 1 is 10 or 12 volts @ 4. A. Winding 2 20 or 22 volts @ 2 A. winding 3 is 20 or 22 volts @ 2 A. Winding 4 is 9 or 11 volts @ 4 A. The isolation winding is about 100 VA. All windings mentioned above have a tap, and both possible voltages are shown for each winding. STOCK NO.B6436 10.95 ea. 2/20.00 (includes capacitor)

STOCK NO.B6437 has 4 windings and an isolation winding. Winding 1 is 22 or 26 volts @2 A. Winding 2 is 17 or 21 volts @6 A. Winding 3 12.5 or 14 volts @ 6 A. and winding 4 is 32 or 35 volts @ 2.5 A. Isolation winding is about 100 VA. All windings have a tap, and both possible voltages are shown for each winding. STOCK NO.B6437 10.95 ea. 2/20.00 (includes capacitor).

Send for our latest free catalog. Minimum order $5, phone orders welcome. Include sufficient postage (2 lbs min.), excess will be refunded. BANKAMERICARD & MASTERCHARGE welcome, ALL numbers needed for processing. Minimum charge $15.

BYTE

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Reader Service

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BOMB— BYTE's Ongoing Monitor Box

BOMB Results, October Issue . . . . . and, Now, a BOMB Card

The results of the BOMB tally for October found a first place evaluation for R Scott Guthrie's part 2 of the "Mathematical Function Unit" description, with second place going to Mike Wilber and Dave Fylstra's article "Homebrewery vs the Software Priesthood." Scott receives a bonus of $100 for his placement, and a check for $50 goes to Mike and Dave for their efforts.

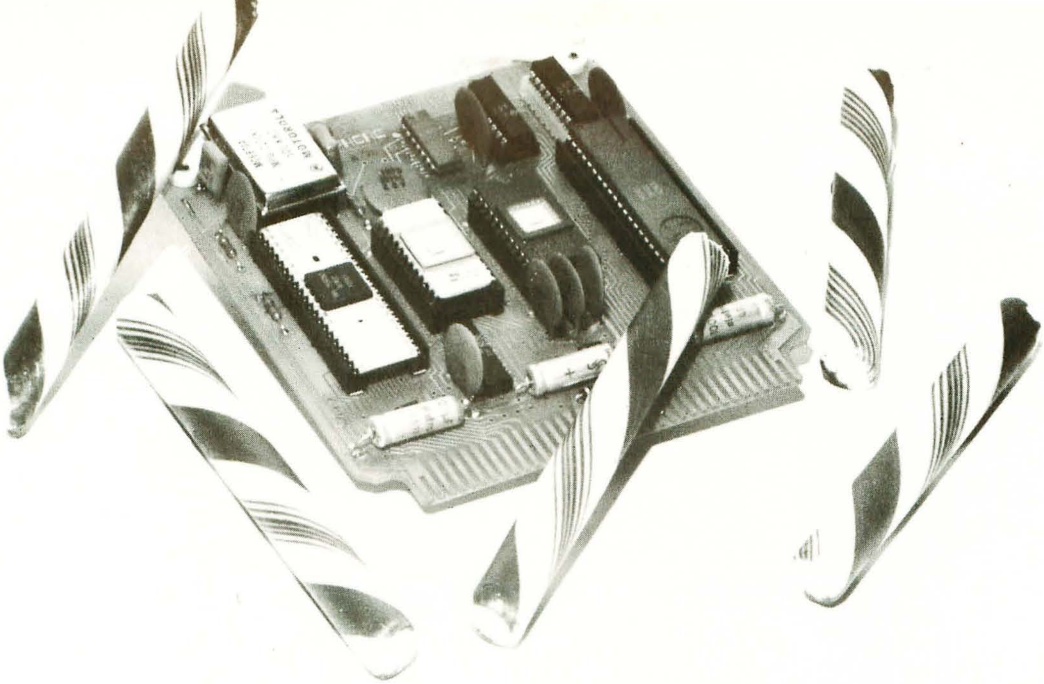
Starting this month, BOMB will achieve a greater level of convenience through the postcard form bound into the issue opposite this page (most people don't like to debauch their BYTEs by ripping up the BOMB page, so they send in photocopies).

BYTE authors appreciate your feedback about their efforts. We recognize this by providing a monthly bonus of $100 and $50 to the two authors with the highest BOMB voting tallies, awards which are above and beyond the normal author's payment for articles.

You can participate in the voting by rating each article on a scale of 0 to 10 using this form. Each article is assigned a unique number in the BOMB section opposite this card. For each article listed, circle your personal rating, then drop the card in the mail with appropriate postage.

The cutoff date for receipt of your BOMB evaluation is the 10th of the month following the month of publication. Thus the January 1977 BOMB ratings are due February 10 1977.■

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6	Baker: Black Friday	56
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